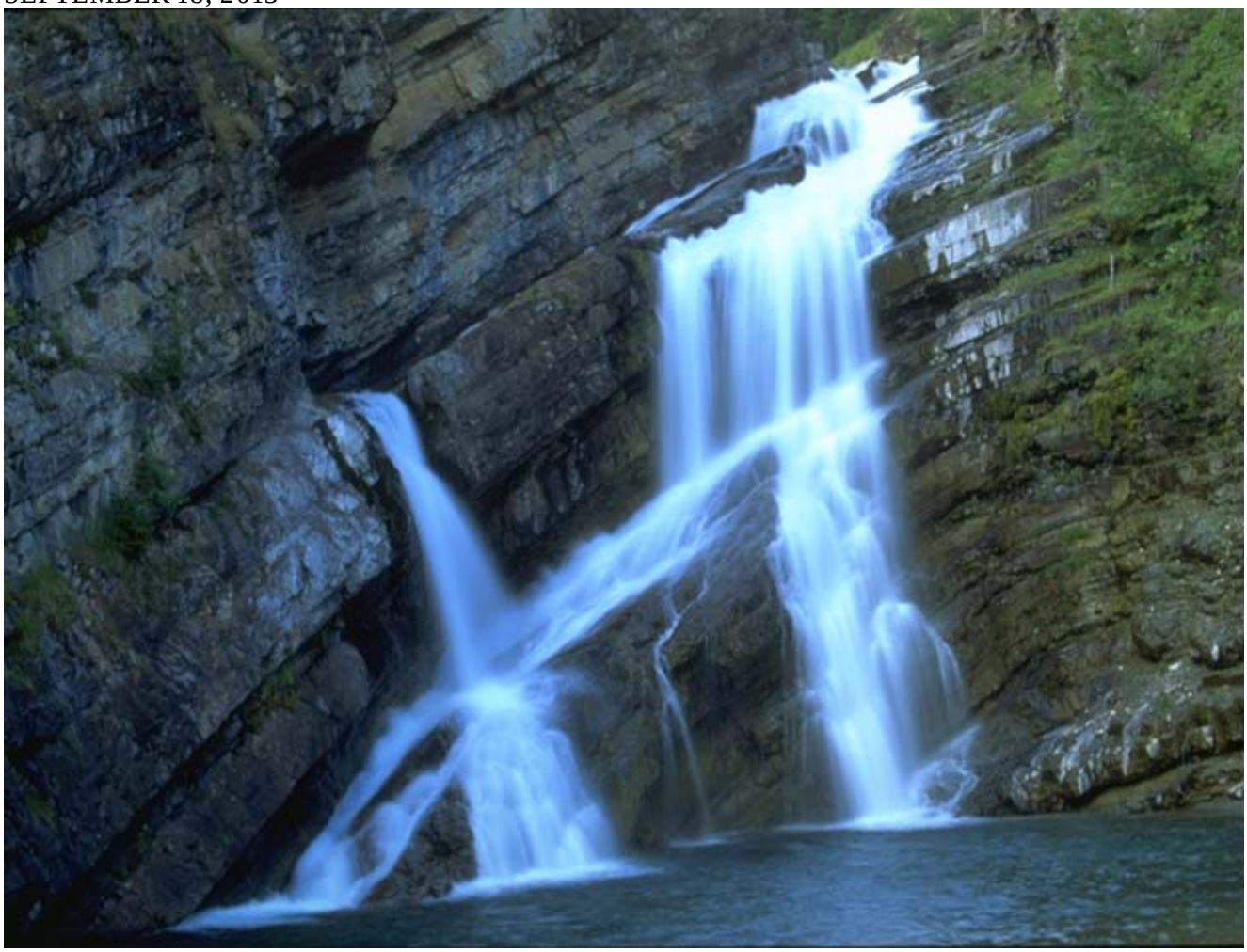
# REMEDIATION WORK PLAN

**MICHIGAN PLAZA**
**3801-3823 WEST MICHIGAN STREET**
**INDIANAPOLIS, INDIANA 46222**
IDEM INCIDENT NO.: 0000198
IDEM VRP NO.: 6061202
MUNDELL PROJECT NO.: M01046
SEPTEMBER 18, 2013

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# REMEDIATION WORK PLAN

## Michigan Plaza
## 3801-3823 West Michigan Street
## Indianapolis, Indiana
## MUNDELL Project No. M01046
## IDEM VRP Site # 6061202

**Prepared for:**

Mr. Peter Cappel
AIMCO Michigan Meadows Holdings
4582 South Ulster Street Parkway, Suite 1100
Denver, Colorado, 80237

September 18, 2013

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September 18, 2013

Mr. Corey Webb
Indiana Department of Environmental Management
Voluntary Remediation Program
Office of Land Quality
MC66-22 IGCN #1101
100 North Senate Avenue
Indianapolis, Indiana 46204-2251

Re: **Remediation Work Plan**
Michigan Plaza
3801-3823 West Michigan Street
Indianapolis, Indiana
VRP Site No. 6061202
MUNDELL Project No. M01046

Dear Mr. Webb:

On behalf of AIMCO Michigan Meadows Holdings (AMMH), Mundell and Associates, Inc. (MUNDELL) is submitting this Remediation Work Plan (RWP) to the Indiana Department of Environmental Management (IDEM) for approval. This RWP provides a summary of the work activities that have been performed and remaining activities to be completed. We appreciate the opportunity to provide you with this information. If you should have any questions regarding the attached submittal, please call MUNDELL at (317-630-9060) at your convenience.

Sincerely,
**Mundell & Associates, Inc.**

Matthew Bono
Staff Environmental Scientist

Mark E. Breting, L.P.G.
Senior Project Geologist

John A. Mundell, P.E., L.P.G.
President/Senior Environmental Consultant

/mb
cc: Mr. Pete Cappel, AMMH

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# EXECUTIVE SUMMARY

On behalf of AIMCO Michigan Meadows Holdings, LLC. (AMMH), Mundell & Associates, Inc. (MUNDELL) is pleased to submit this Remediation Work Plan (RWP) for the Michigan Plaza retail facility located between 3801 and 3823 West Michigan Street, and Maple Creek Village Apartments (formerly the Michigan Meadows Apartments), located at 3800 West Michigan Street, Indianapolis, Indiana (herein termed "the Site"). AMMH enrolled the Site into the Indiana Voluntary Remediation Program (VRP) in January 2007 to address on-site and off-site soil and groundwater impacts. (IDEM Incident Number 0000198 and IDEM VRP Site Identification Number 6061202).

This document summarizes site investigation activities to date and presents the selected remediation technology chosen to address soil and groundwater impacts present at the Site. The RWP also details proposed remediation efforts that will address groundwater downgradient (south) of the Site.

## *Site Setting and History*

The Site is located to the east of the intersection of West Michigan Street and Holt Road in a mixed residential/commercial setting on the near west side of Indianapolis. The Site currently consists of a strip mall along the south side of West Michigan Street and a multi building apartment complex to the north of the street. The apartment complex consists of several apartment buildings and support buildings on approximately 13.7 acres and, the Michigan Plaza facility consists of a single multi-tenant retail facility covering approximately 1.5 acres. Impacts at the Site to soil, soil vapor, indoor air and groundwater are believed to have resulted from historic dry-cleaning operations at the Michigan Plaza by a company called Accent Cleaners while coincident soil vapor, indoor air and groundwater impacts resulted from the adjacent former General Motors Corporation Allison Gas Turbine Division (GM AGT) Plant 10 (also known as the Genuine Site) to the north. The exact timing of subsurface impacts is not known; however, they are believed to have occurred sometime during the active operation of the former Accent Cleaners (between about 1971 and 1995), and the Genuine Site (operated by a company named BHT Corporation between about 1956 and 1973 as a carburetor and brake re-manufacturing facility that had active degreasing activities), respectively.

## *Soil and Groundwater Impacts*

The results of the historic Site investigations completed since 2001 indicates that chlorinated volatile organic chemicals (cVOCs) are present in the subsurface soils, soil gas, indoor air and groundwater at the Site. Three chemical source areas associated with the historic solvent discharges from the dry cleaners to a leaky sewer line have been identified (Source Areas A, B and C). The primary chemicals of concern (COCs) for the Site are tetrachloroethylene (PCE)

and its breakdown products, including trichloroethylene (TCE), cis-1,2-Dichloroethylene (cis-1,2-DCE) and vinyl chloride (VC), which have been present above 2009 IDEM Risk Integrated System Closure (RISC) Default Commercial/Industrial and/or Residential closure levels for soil and groundwater, and above the more recently implemented 2012 IDEM Remediation Closure Guide (RCG) Commercial/Industrial and/or Residential Screening Levels for groundwater and indoor air. COCs have also been present in soils above 2012 IDEM RCG Migration to Groundwater (MTG) Screening Levels. Vapor mitigation systems have been installed and operated at Michigan Plaza since 2006 at the Apartment complex since 2008 to address vapor intrusion concerns. These systems will continue to operate until the cleanup objectives have been met.

### *Geologic and Hydrogeologic Setting*

Groundwater at the Site is present in an upper sand unit that extends from near the ground surface or below a surficial layer of cohesive deposits (up to about 10.0 feet thick). This upper sand unit varies in thickness from about 20 feet to 35 feet across the Site with occasional thin fine-grained silt and clay lenses interspersed. Beneath the upper sand unit, the upper surface of a more laterally extensive till unit (between about El 675 and 685 ft-MSL) is present below the southern half of the Maple Creek Village apartment complex, and extends south below the Michigan Plaza property and the adjacent Floral Park cemetery. This unit has been shown to be areally extensive and of sufficient thickness to act as a vertical barrier to the groundwater impacts caused by the historical chemical releases at Michigan Plaza. A complete monitoring well network has been established within and downgradient of the identified chemical source areas that have fully delineated groundwater impacts. Many of these monitoring wells are installed as nested pairs with “shallow” wells screened across the top of the aquifer and “deep” wells screened near or at the top of the extensive till unit. PCE has been detected in wells screened across the water table, but not in the deeper screened wells.

### *Conceptual Site Model*

The conceptual site model for risk evaluation for the Site identified three chemical source areas (*Areas A*, *B* and *C*) located at the former drycleaning operations and along the sewer discharge from the Michigan Plaza as the primary on-site source areas and historic chemical releases from the upgradient Genuine Site as the primary off-site source area. The initial on-site primary release mechanism was the discharge of solvent-containing wastewaters into the sewers, and then the leakage of the wastewaters from the sewer and infiltration into the subsurface soils and groundwater within an upper sand unit. The four COCs identified (PCE, TCE, cis-1,2-DCE and VC) have moved to a limited extent to the south-southeast from the leakage locations in the direction of groundwater flow. The upgradient Genuine Site groundwater impacts have moved southward in the deep portions of the upper sand unit through the entire Apartments and Plaza properties and beyond. It is likely the Genuine Site has also contributed to groundwater impacts in a lower sand unit as well.

Two primary exposure pathways are considered relevant for the Site: on-site and off-site inhalation of impacted indoor air, and potential off-site ingestion of groundwater. As a result of detectable concentrations of COCs in the leased spaces of Michigan Plaza tenants and Maple Creek Village residents, active vapor mitigation systems were installed and are controlling the

exposure to impacted indoor air to acceptable risk levels while remediation is ongoing. The potential exposure pathway for off-site inhalation of indoor air at nearby residences affected by the presence of impacted groundwater remains and is currently being assessed.

Review of the Indiana Department of Natural Resources low-capacity and high-capacity well records database, the City of Indianapolis and Town of Speedway water supply hookups, and area land use inspections indicate that no groundwater is actively being ingested on-site and downgradient off-site in the area of groundwater impacts attributed to the former Accent Cleaners releases. Low-level chlorinated solvent groundwater impacts have, however, been detected in a number of residential homes west of Holt Road that are also hydraulically downgradient from the Genuine Site. These homes have been provided activated carbon water treatment systems by the U.S. EPA.

An Environmental Restrictive Covenant (ERC) was placed on the Michigan Plaza and Michigan Meadows Apartments properties in October 2008 that restricted groundwater from being used as a drinking water source. Without an ERC on downgradient properties that excludes the use of groundwater as a drinking water source, the potential still exists for the accidental ingestion of groundwater by a future off-site user. This general area of Indianapolis, however, is within a current No Well Zone (NWZ) established by the Marion County Health Department (MCHD) as a result of the widespread groundwater impacts that have been identified from past industrial operations in the area. This NWZ status allows MCHD to control the approval of all requests for water supply wells in the area until such a time that active remediation restores the quality of the groundwater to a drinkable condition. Because of this NWZ, the accidental ingestion of impacted groundwaters is expected to be closely controlled to acceptable levels until remedial activities are completed.

## *Remedial Action Objectives (RAOs)*

Remedial Action Objectives (RAOs) are specific remediation and cleanup goals for protecting human health and the environment. The National Contingency Plan (NCP) specifies that RAOs be developed which address: (1) each contaminant of concern, 2) each media of concern, 3) each potential exposure pathway, and 4) remediation levels. The Primary RAOs listed below for this Site are considered the minimum “priority” cleanup objectives that need to be met prior to pursuing site closure, and will guide the continued pursuit of secondary RAOs, which may or may not need to be *completely* achieved in order to otherwise sufficiently address exposure risks associated with the Site COCs

Based on completed or potential exposure pathways (on-site and off-site vapor inhalation and potential off-site groundwater ingestion) and the projected future Site use as commercial tenant (Michigan Plaza) and residential dwellings (Maple Creek Village), the following Primary and Secondary RAOs for the Site will be pursued:

*Primary RAO – Indoor Air: Michigan Plaza*

Michigan Plaza will be remediated to attain 2012 IDEM Remediation Closure Guide (RCG) Indoor Air (IA) Commercial/Industrial (C/I) screening levels with an Environmental Restrictive Covenant (ERC) which precludes use of the facility leased space for daycare, or, if not achieved, to attain IDEM RCG IA C/I screening levels with an ERC which excludes use of the

facility leased space for day care and requires the operation of active vapor mitigation systems with periodic confirmation air sampling.

Primary RAO – Indoor Air: Maple Creek Village Apartments:

The Maple Creek Village Apartments will be remediated to attain IDEM RCG IA Residential screening levels without operating vapor mitigation systems, or, if not achieved, to attain IDEM RCG IA Residential screening levels with an ERC that requires operation of active vapor mitigation systems with periodic verification air sampling.

*Primary RAO – Off-Site Shallow Groundwater*

The shallow groundwater south-southeast and downgradient of Michigan Plaza on the Floral Park Cemetery property will be remediated to attain IDEM RCG Residential tap water screening levels without an ERC or, if not achieved, to attain IDEM RCG C/I VI Groundwater Screening Levels (GWSLs) with an ERC prohibiting the Floral Park Cemetery property's use of groundwater for drinking water, and providing technical evidence in the Remediation Closure Report (RCR) that the remaining impacts in the shallow groundwater will not extend beyond the limits of the Floral Park Cemetery property at levels above the IDEM residential tap water standards.

*Primary RAO – Off-Site Deep Groundwater*

The deep groundwater south and downgradient of Michigan Plaza on the Floral Park Cemetery property will be remediated to attain IDEM residential tap water screening levels without an ERC or, if not achieved, to attain five times (5 X) IDEM RCG C/I VI GWSLs with an ERC on the Floral Park Cemetery property restricting the use of groundwater for drinking water, and providing technical evidence in the RCR that the remaining impacts in the deep groundwater will not extend beyond the limits of the Floral Park Cemetery property at levels above the IDEM residential tap water standard. If neither of these are achieved, then the groundwater will be remediated to attain the background levels associated with the deep Genuine groundwater plume immediately upgradient of the Maple Creek Village Apartments property.

*Secondary RAO – On-Site Soil: Michigan Plaza*

Michigan Plaza soils will be remediated, as needed, to attain IDEM RCG soil MTG screening levels, or until IDEM RCG IA C/I screening levels at Michigan Plaza have been achieved with or without an operating vapor mitigation system.

*Secondary RAO – On-Site Soil: Maple Creek Village Apartments*

Maple Creek Village Apartments soils will be remediated, as needed, to IDEM RCG soil MTG screening levels, or until IDEM RCG IA residential screening levels at Maple Creek Village Apartments have been achieved with or without an operating vapor mitigation system.

*Secondary RAO – On-Site Shallow Groundwater: Michigan Plaza*

Michigan Plaza on-site shallow groundwater will be remediated, as needed, to attain:

- IDEM RCG Residential VI GWSLs or IDEM RCG IA Residential screening levels, or, if not achieved:

- IDEM RCG C/I VI GWSLs or IDEM RCG IA C/I screening levels, with an ERC placed onto the property restricting use of tenant spaces to businesses that would be considered "commercial" in nature and not "residential" in nature (e.g., daycare or after school programs, etc.), or, if not achieved:

- IDEM RCG IA C/I screening levels with an active vapor mitigation system verified by periodic sampling and testing required by an ERC placed onto the property, and restricting use of tenant spaces to businesses that would be considered "commercial" in nature and not "residential" in nature (e.g., daycare or after school programs, etc.).

*Secondary RAO – On-Site Shallow Groundwater: Maple Creek Village*

Maple Creek Village on-site shallow groundwater will be remediated, as needed, to attain:

- IDEM RCG Residential VI GWSLs or IDEM RCG IA Residential screening levels, or, if not achieved:

- IDEM RCG IA Residential screening levels with an ERC placed onto the property requiring an active vapor mitigation system verified by periodic sampling and testing.

*Secondary RAO – On-Site Deep Groundwater: Michigan Plaza*

Michigan Plaza on-site deep groundwater will be remediated, as needed, to attain:

- IDEM RCG Residential VI GWSLs or IDEM RCG IA Residential screening levels, or, if not achieved:

- IDEM RCG C/I VI GWSLs if an ERC is placed onto the property restricting use of tenant spaces to businesses that would be considered "commercial" in nature and not "residential" in nature (e.g., daycare or after school programs, etc.), or, if not achieved:

- IDEM RCG IA C/I screening levels with an active vapor mitigation system verified by periodic sampling and testing required by an ERC placed onto the property, and restricting use of tenant spaces to businesses that would be considered "commercial" in nature and not "residential" in nature (e.g., daycare or after school programs, etc.), or, if not achieved:

- background levels associated with the Genuine plume immediately upgradient of the Maple Creek Village Apartments property.

*Secondary RAO – On-Site Deep Groundwater: Maple Creek Village Apartments*

Maple Creek Village Apartments on-site deep groundwater will be remediated, as needed, to attain:

- IDEM RCG Residential VI GWSLs or IDEM RCG IA Residential screening levels, or, if not achieved:

- IDEM RCG IA Residential screening levels with an active vapor mitigation system verified by periodic sampling and testing required by an ERC placed onto the property, or, if not achieved:

- background levels associated with the Genuine plume entering the southern portion of the Maple Creek Village Apartments property.

It should be emphasized that the attainment of the Secondary RAOs is only for the purpose of achieving the Primary RAOs. As such, if the Secondary RAOs have not been fully attained prior to the achievement of the Primary RAOs, and the relevant exposure pathways of on-site and off-site vapor inhalation and off-site groundwater ingestion have been addressed, then final site closure will be pursued.

Depending on the actual exposure conditions and chemical trends that are present during active remedial activities, this RWP will also allow for the possibility of performing a site-specific risk assessment in order to select final cleanup objectives that are appropriate for the protection of human health and the environment.

**It should be emphasized that this RWP is not intended to remediate deep groundwater affected by the Genuine plume migrating below the Michigan Plaza and Maple Creek Village Apartments. As such, an assessment of the groundwater concentrations (and mass flux) coming into the Site from Genuine is essential in determining the ultimate appropriate cleanup goals.**

### *Proposed Remediation Alternatives*

This RWP outlines the proposed remediation methods to decrease concentrations of COCs to below the proposed cleanup goals. MUNDELL is proposing a combination of technologies to cost-effectively remediate chlorinated solvent impacts at the Site. The proposed groundwater remediation alternative consists of in-situ bioremediation of the impacted groundwater plume through the injection of a food grade, vegetable oil product (CAP18 ME®). This groundwater remediation alternative has been previously approved by IDEM at this Site and has consisted of the injection of CAP18 ME® into the impacted groundwater within three Source Areas in multiple groupings and permeable reactive barrier lines oriented perpendicular to the groundwater flow direction over the course of three events (August 2007, February 2009, and most recently in July 2013). Per the CAP18 ME® injection workplan approval by IDEM on June 3, 2013, the third round of CAP18® injection activities were completed prior to the current RWP submittal. Soil and groundwater remediation is expected to require three to five years to reach cleanup goals.

The CAP18 ME® injection points were installed at a spacing of approximately 10 to 15 feet between points, with the vertical injection thicknesses and injection quantities selected to encompass the ‘smear zone’ and the entire saturated portion of the upper sand unit. Reducing bacteria were also included as part of the injectant mass during the July 2013 activities.

Groundwater, soil gas, vapor and indoor air monitoring activities are continuing to be conducted on a quarterly basis to determine the progress toward achieving cleanup goals.

Depending on the responsiveness of the groundwater and indoor air quality chemical concentration trends to the CAP18 ME® injections, additional remedial activity will be considered to treat any remaining residual chlorinated vadose zone soil concentrations in the three chemical source areas. As an optional additional alternative to address any residual adsorbed cVOCs in the vadose zone, MUNDELL proposes application of a mobile Soil Vapor Extraction (SVE) unit to remove additional contaminant mass, thereby reducing the main exposure pathway concern (VI) and minimize any groundwater rebound of PCE. Use of the mobile SVE unit would also have the added effect of reducing potential leaching to groundwater associated with any smear zone cVOC mass that is flushed during high water periods, or by downward percolating surface recharge in non-paved areas. If selected, the optional SVE activities can begin within three months of IDEM approval.

Remedial action at the Site will conclude with demonstration, through confirmation sampling and testing, that the primary cleanup objectives (on-site and off-site VI, off-site groundwater) have been achieved and that no completed exposure pathways remain.

### *Groundwater Monitoring and Site Closure*

Groundwater closure will be demonstrated through two years of quarterly monitoring following the groundwater remediation activities to confirm that either cleanup objectives have been achieved, or that the chlorinated solvent plumes (PCE, TCE, cis-1,2-DCE and VC) are stable or decreasing and that existing and potential exposure pathways have been either controlled to acceptable levels.

A Remediation Completion Report (RCR) will be submitted once cleanup goals are achieved. An Environmental Restrictive Covenant (ERC) will be recorded stating that the Michigan Plaza property will remain non-residential. Other ERCs and restrictions may also apply at that time. At the time of site closure, a certificate-of-completion and a covenant-not-to-sue will be sought from IDEM and the Governor's Office of Indiana.

# 1.0 INTRODUCTION

## 1.1 Project Background

Michigan Plaza (also referred to as "the Plaza") is a multi-unit commercial development comprising addresses between 3801-3823 on West Michigan Street in Indianapolis, Indiana in Marion County. The Maple Creek Village Apartments (formally known as Michigan Meadows Apartments and also referenced as the "Apartments" in this document) are located across Michigan Street to the north at 3800 West Michigan Street in Indianapolis, Indiana. The properties are located in a mixed residential/commercial and industrial area on the west side of Indianapolis, as shown in **Figure 1**. A map showing the Plaza and the Apartments with the surrounding areas is presented in **Figure 2a.** The current owners of the Plaza and the Maple Creek Village Apartments properties are, respectively, Gennx Properties VI, LLC and Gennx Properties VII, LLC. The properties are managed by the Real Estate Alternative, LLC, which maintains an office at the Apartments and a local phone number of 317-244-7201.

AIMCO Michigan Meadows Holdings, LLC (AMMH) previously owned the two properties at the time the pre-existing environmental impacts associated with historic tenant site activities were first identified. AMMH initiated the subsequent environmental investigative and remedial activities to address the environmental conditions, and maintains this oversight role to date. The AMMH contact person is Mr. Peter Cappel in the AIMCO national office in Denver, Colorado. Addresses for each of the owner contacts are as follows:

<u>AMMH</u>
Attention: Mr. Peter Cappel, Vice President of Environmental Health and Safety
AIMCO
4582 South Ulster Street Parkway, Suite 1100
Denver, CO 80237
(303) 691-4560

<u>Gennx Properties VI and Gennx Properties VII, LLC</u>
Attention: Mr. Kevin Krulewitch
234 E. 9th Street Suite B-01
Indianapolis, IN 46204
(317) 955-7572

<u>Michigan Plaza/Maple Creek Village Real Estate Manager</u>
Attention: Mr. Kevin Krulewitch,
The Real Estate Alternative, LLC
3800 W. Michigan St. #1206
Indianapolis, IN 46222

(317) 955-7572

MUNDELL Senior Project Manager
Attention: Mr. Mark Breting, L.P.G.
Mundell & Associates, Inc.
110 South Downey Ave.
Indianapolis, IN 46219
(317) 630-9060

The Indiana Department of Environmental Management (IDEM) Voluntary Remediation Program (VRP) project number is 6061202. This Remediation Work Plan (RWP) has been developed to address impacts that have originated on and are present beneath the Plaza property, and have also migrated into the subsurface in the southern and southeast portion of the Apartments property and the northern portion of the Floral Park Cemetery property. The Plaza property and the Apartments property is herein termed the "Site", the features of which are depicted on **Figure 2a.**

Michigan Plaza currently consists of a single story, 'L' shaped commercial building with six retail and office tenants and an asphalt-paved parking lot on approximately 1.5 acres of land. The Plaza currently consists of a former Village Pantry (3801), the Kids-X-Clusive daycare facility (3807/3809), the West Michigan Street Veterinary Clinic (3811), an Alcoholics Anonymous office (3817), the Iglesia Arca de Salvacion (3819), and the Michigan Plaza Family Laundry (3823). The Maple Creek Village Apartments currently consists of 23 apartment buildings and one swimming pool, of which only three apartment buildings are part of the Site area this RWP specifically addresses: Apartment Building No. 1, Apartment Building No. 6, and Apartment Building No. 10.

Records indicate that the Plaza and Apartments land was farmland/residential prior to the 1960s. The commercial building was reportedly constructed in the mid to late-1960s, and there have not been any additions to the building since its original construction. Property information records indicate that the property was owned by David C. Eades and Roy H. Lambert in 1978. Prior ownership information is not available. AMMH purchased the Site in December 1999. On May 8, 2008, as part of a corporate reorganization, AMMH quitclaimed the deed to the Michigan Meadows Apartments and Michigan Plaza properties to AIMCO Michigan Apartments, LLC, a Delaware limited liability company. Several months after the corporate reorganization on October 10, 2008, AIMCO Michigan Apartments, LLC sold the Michigan Meadows Apartments and Michigan Plaza properties to GenNx Properties VI, LLC and GenNx Properties VII, LLC, respectively. The Plaza is currently managed by The Real Estate Alternative, LLC.

A Phase I Environmental Site Assessment (ESA) was performed for Regency Windsor Companies of Vero Beach, Florida by Alt & Witzig Engineering, Inc. in June 1992 (A &W, 1992b) for the Michigan Plaza property. In the Phase I ESA, Alt & Witzig identified the presence of Accent Cleaners at the 3819 West Michigan Street address during the site reconnaissance visit. A subsequent Phase I ESA by Commercial Inspectors in

April 1999 did not identify Accent Cleaners or the Genuine site as concerns. MUNDELL completed Phase I ESAs for both the Plaza (Mundell, 2003d) and the Apartments (MUNDELL, 2003e), and confirmed the presence of Accent Cleaners at the Plaza property, as well as 1994/95 records at the Marion County Health Department indicating the use of PCE.

Based on a MUNDELL review of city directory listings as part of an earlier RWP preparation, Accent Cleaners or Accent Dry Cleaners was a business in operation at this location since 1971. Records indicate Neff Cleaners was associated with the address in 1970. Based on the directory information, it does not appear that a business occupied the tenant space prior to 1970, roughly the period following building construction and initial tenant leasing.

Prior to 1956, the property north of the Apartments was vacant land. Between 1956 and 1973, a company named BHT Corporation (BHT) utilized trichloroethylene (TCE) and tetrachloroethylene (PCE) as a parts degreaser in their parts rebuilding operations from the 1950s to the 1970s. BHT operated the facility for carburetor and brake re-manufacturing. General Motors purchased the property from BHT in 1973, and subsequently used it for warehousing obsolete machines, tooling, and fixtures until the mid-1980s. The property became part of the General Motors Corporation Allison Gas Turbine (GM AGT) Division in 1973.

Environmental subsurface investigations conducted by a number of environmental consultants (*e.g.*, Engineering Science, Inc.; Fluor Daniel GTI, Keramida Environmental, ENVIRON) since 1992 have disclosed chlorinated volatile organic chemical (cVOC) impacts to area groundwater from the operations of the former GM AGT Plant 10 facility located at 700 North Olin Avenue due north of the Maple Creek Village Apartments across Little Eagle Creek. The former GM AGT Plant 10 facility has been entered into the IDEM VRP by the Genuine Parts Company (hereinafter referred to as the Genuine Site).

After discovery of groundwater impacts at the Apartments property, AMMH's counsel retained MUNDELL in late 2001 to begin to review site investigation results and remedial work plans prepared by Keramida for the former GM AGT site. MUNDELL completed Phase I ESAs for both the Plaza (MUNDELL, 2003d) and the Apartments (MUNDELL, 2003e) in 2003. MUNDELL's Phase I ESA also identified the past presence of Accent Cleaners at the Plaza property, and the 1994 and 1995 records at the Marion County Health Department that indicated the use of tetrachloroethene (a.k.a. perchloroethene, or "PCE"), and documented waste management violations. Since 2003, MUNDELL has completed several subsurface investigations and indoor air quality studies for the Apartments and Michigan Plaza, summarized in Section 1.2.

The results of the previous site investigations indicate that cVOCs, consisting primarily of PCE, are present in the subsurface soil, groundwater, soil gas and indoor air at the Site as a result of releases from the past Site operations of Accent Cleaners, while cVOCs

(generally excluding PCE and TCE) are present in groundwater and to some extent soil gas and indoor air from upgradient chemical source areas located at the Genuine site. The primary chemicals of concern (COCs) for the Site, therefore, are PCE and its breakdown products, including TCE, cis-1,2-Dichloroethylene (cis-1,2-DCE) and vinyl chloride (VC), which are present both above cleanup goals under the previously applicable IDEM Risk Integrated System of Closure (RISC) Industrial and Residential Default Closure Levels (IDCLs and RDCLs) for soil, groundwater, and vapor, and above the current IDEM Remediation Closure Guide (RCG) screening levels. The results show exceedances of Commercial/Industrial and Residential Screening Levels for Vapor Intrusion (VI) from Groundwater, Soil Direct Contact (SLC) Screening Levels for residential and commercial scenarios, and Migration To Groundwater (MTG) screening levels.

The exact timing and quantities of chemicals releases into the subsurface are not known with certainty. However, they are believed to have occurred sometime during the active operation of the former Accent Cleaners (between about 1971 and 1995), and the Genuine Site (operated by a company named BHT Corporation between about 1956 and 1973 as a carburetor and brake re-manufacturing facility that had active degreasing activities). Limited active on-site remediation of chemical source areas on the Genuine site have not prevented cis1,2-DCE and VC groundwater impacts from migrating onto the Site. As a result, dissolved cis-1,2-DCE and VC moving downgradient of Genuine are present in groundwater beneath nearly all of the Apartments and Michigan Plaza. An absence of detectable PCE in groundwater beneath all but the southern and southeastern area of the Apartments property and the presence of PCE at Michigan Plaza indicates that a separate PCE source has been present on or near the Plaza property. Investigation activities performed by MUNDELL have concluded that historical releases of PCE into the subsurface in the vicinity of the former Accent Cleaners unit, and periodic discharges of facility wastewaters to the sanitary sewer system have dispersed the solvent into the subsurface along points in this sewer system. It is this source of PCE from the Plaza that this RWP addresses.

In January 2007, IDEM accepted the Site into the IDEM VRP and assigned site identification number 6061202. IDEM executed the Voluntary Remediation Agreement on April 20, 2007. Following a review of MUNDELL's Further Site Investigation Addendum I April 1, 2007 report detailing investigation activities at that time, IDEM issued a letter dated May 4, 2007 indicating that development of a RWP to address the shallow zone of the aquifer could begin. A copy of the letter is provided in **Appendix A.** As a result of the environmental conditions detected on the property, an Environmental Restrictive Covenant (ERC) was recorded on the Site on October 20, 2008 that imposed the restriction of no consumptive, extractive or other use of the groundwater beneath the property other than for site investigation and/or remediation purposes. A copy of this ERC is provided in **Appendix A**.

Since acceptance in the IDEM VRP in 2007, additional investigations and active remediation of the soil and groundwater impacts have been undertaken. These will be more fully discussed in **Sections 2.2** and **3.4.2**.

## 1.2 Supporting Documentation

A number of technical reports and IDEM response letters documenting the subsurface investigations and contamination assessments described above have been completed for the Genuine Site, the Apartments and the Plaza. A list of the primary investigation reports, sampling events and remediation activities conducted by MUNDELL in the vicinity of the Apartments and Plaza properties over the duration of the project follows:

**INSET TABLE 1. LISTING OF PREVIOUS TECHNICAL REPORTS**

| Report Title | Report Date |
|---|---|
| Alt & Witzig Phase I Environmental Site Assessment, Michigan Meadows Apartments | 5/6/1992 |
| Alt & Witzig Phase I Environmental Site Assessment, Michigan Plaza | 6/24/1992 |
| Commercial Inspectors Environmental Site Assessment | 4/27/1999 |
| Air Quality Monitoring Report, Michigan Meadows Apartments | 1/18/2002 |
| Air Quality Investigation Report, Michigan Meadows Apartments and Michigan Plaza Shopping Center | 6/9/2003 |
| Phase I Environmental Site Assessment, Michigan Meadows Apartments | 12/29/2003 |
| Phase I Environmental Site Assessment, 3801-3823 West Michigan Street | 12/29/2003 |
| Keramida Split Groundwater Sampling Event - March 2004 Michigan Meadows Apartments | 6/30/2004 |
| Phase II Environmental Site Assessment, Michigan Plaza | 2/16/2005 |
| Air Quality Investigation Report - October 2004, Michigan Meadows Apartments and Michigan Plaza Shopping Center | 4/4/2005 |
| Phase II Environmental Site Assessment, Michigan Meadows Apartments | 5/5/2005 |
| Geophysical Survey and Anomalies Investigation Report | 7/20/2005 |
| Further Site Investigation (FSI) Report | 5/10/2006 |
| Indoor Air Mitigation System Installation Report – September 2006 | 9/26/2006 |
| Further Site Characterization Study Michigan Plaza | 12/1/2006 |
| Further Site Investigation Addendum I report | 4/1/2007 |
| Quarterly Monitoring Progress Report - 2Q07 | 8/15/2007 |
| Remediation Work Plan (RWP) | 2/22/2008 |
| Response to IDEM Comments to RWP | 9/25/2008 |
| RWP Addendum I | 11/6/2008 |
| Response to IDEM RWP Response to Comments & Addendum I Review | 1/16/2009 |

| Report Title | Report Date |
|---|---|
| Quarterly Monitoring Progress Report - 4Q08 | 10/22/2009 |
| Quarterly Monitoring Progress Report - 1Q09 | 10/31/2009 |
| Further Sewer Evaluation | 11/11/2009 |
| Quarterly Monitoring Progress Report - 2Q09 | 12/16/2009 |
| Quarterly Monitoring Progress Report - 3Q09 | 1/28/2010 |
| Quarterly Monitoring Progress Report - 4Q09 | 1/28/2010 |
| Quarterly Monitoring Progress Report - 1Q10 | 4/30/2010 |
| Quarterly Monitoring Progress Report - 2Q10 | 8/26/2010 |
| Quarterly Monitoring Progress Report - 3Q10 | 11/10/2010 |
| Work Plan for 3rd Round of CAP 18 ME Injections | 3/16/2011 |
| Revised Workplan for 3rd Round CAP18 ME Injections | 3/28/2011 |
| Quarterly Monitoring Progress Report - 4Q10 | 2/16/2011 |
| Request for Revised RWP Approval | 4/21/2011 |
| Quarterly Monitoring Progress Report - 1Q11 | 5/4/2011 |
| Revised Workplan for 3rd Round CAP18 ME Injections | 7/22/2011 |
| Quarterly Monitoring Progress Report - 2Q11 | 9/8/2011 |
| Quarterly Monitoring Progress Report - 3Q11 | 10/31/2011 |
| Notification of Additional Soil and Groundwater Investigation Activities | 11/30/2011 |
| Interim Response and Activity Update Report to IDEMs Request for Revised RWP Approval Review and Technical Response to General Notice of Potential Liability Review | 12/1/2011 |
| Quarterly Monitoring Progress Report - 4Q11 | 1/31/2012 |
| Additional Investigation Activities Summary Report | 3/16/2012 |
| Response to IDEMs Request for Revised RWP Approval Review and Technical Response to General Notice of Potential Liability Review | 3/16/2012 |
| Revised Workplan for 3rd Round CAP18 ME Injections | 5/2/2012 |
| Quarterly Monitoring Progress Report - 1Q12 | 6/12/2012 |
| Quarterly Monitoring Progress Report - 2Q12 | 10/22/2012 |
| Response to IDEMs November 1, 2012 Review of Additional Investigation | 12/21/2012 |
| Quarterly Monitoring Progress Report - 3Q12 | 1/21/2013 |
| Quarterly Monitoring Progress Report - 4Q12 | 1/31/2013 |
| Second Revised Work Plan for the Third Round of CAP18 ME Injection and Interim Remediation Alternative Alternative Description Summary Report | 2/20/2013 |
| Technical Response to "Technical Memorandum: Analytical and Hydrogeological Evaluation, West Vermont Street Site, Speedway, Marion County, Indiana" Prepared for USEPA by Weston Solutions, Inc. (January 30, 2013) | 4/18/2013 |
| Response to IDEM's Review of Second Revised Work Plan For the Third Round of CAP 18®ME™ Injections | 4/30/2013 |
| Quarterly Monitoring Progress Report - 1Q13 | 4/30/2013 |
| Quarterly Monitoring Progress Report - 2Q13 | 8/9/2013 |

A summary of the primary results and conclusions from these investigations and sampling events relevant to the overall development of this RWP is given in **Section 2.2.** Documents and reports produced from these investigations and sampling events, along with additional supporting documents that have contributed to the overall development of this project are provided in the listing of references in **Section 4.0**.

## 1.3 Remedial Action Objectives

Remedial Action Objectives (RAOs) are specific remediation and cleanup goals for protecting human health and the environment. The National Contingency Plan (NCP) specifies that RAOs be developed which address: (1) each contaminant of concern, 2) each media of concern, 3) each potential exposure pathway, and 4) remediation levels. The Primary RAOs listed below for this Site are considered the minimum "priority" cleanup objectives that need to be met prior to pursuing site closure, and will guide the continued pursuit of secondary RAOs, which may or may not need to be *completely* achieved in order to otherwise sufficiently address exposure risks associated with the Site COCs

As will be discussed in **Section 3.0**, the relevant exposure pathways for the Site are on-site and off-site **vapor inhalation**, and potential off-site **groundwater ingestion**. Active soil and groundwater remediation is required to reduce contaminant concentrations for the aforementioned pathways to relevant cleanup goals. Based on these completed or potential exposure pathways and the projected future Site use as commercial tenant (Michigan Plaza) and residential dwellings (Maple Creek Village), the following Primary and Secondary RAOs for the Site will be pursued:

### 1.3.1 Primary RAOs

#### 1.3.1.1 Indoor Air – Michigan Plaza

- Indoor air (IA) at Michigan Plaza will be remediated to attain IDEM Remediation Closure Guide (RCG) Indoor Air (IA) Commercial/industrial (C/I) screening levels without an operating vapor mitigation system and an Environmental Restrictive Covenant (ERC) which precludes use of the facility leased space for daycare, or, if not achieved,

- To attain IDEM IA C/I screening levels using active vapor mitigation systems with an ERC which precludes use of the facility leased space for daycare and requires the operation of active vapor mitigation systems with periodic confirmation air sampling.

#### 1.3.1.2 Indoor Air – Maple Creek Village Apartments

- Indoor air at Maple Creek Village Apartments will be remediated to attain IDEM RCG IA residential screening levels without operating vapor mitigation systems, or, if not achieved:

- To attain IDEM RCG IA residential screening levels with an ERC that requires operations of active vapor mitigation systems with periodic confirmation air sampling.

#### 1.3.1.3 Off-Site Shallow Groundwater – South of Michigan Plaza

Off-site shallow groundwater located to the south of the Michigan Plaza:

- Will be remediated to attain IDEM RCG Residential tap water screening levels without an Environmental Restrictive Covenant (ERC) on the Floral Park Cemetery, or, if not achieved:

- To attain IDEM RCG C/I VI Groundwater Screening Levels (GWSLs) with an ERC prohibiting the Floral Park Cemetery's property's use of groundwater as drinking water and providing technical evidence in the Remediation Completion Report (RCR) that the remaining impacts in the shallow aquifer will not extend beyond the limits of the Floral Park Cemetery at levels above the IDEM RCG residential tap water standards.

#### 1.3.1.4 Off-Site Deep Groundwater - South of Michigan Plaza

Off-site deep groundwater located to the south of the Michigan Plaza:

- Will be remediated to attain IDEM RCG Residential tap water screening levels without an ERC on the Floral Park Cemetery, or, if not achieved:

- To attain five times (5 x) the IDEM RCG C/I VI GWSLs with an ERC on the Floral Park Cemetery restricting the use of groundwater as drinking water and providing technical evidence in the RCR that the remaining impacts in the deep aquifer will not extend beyond the limits of the Floral Park Cemetery at levels above the IDEM RCG residential tap water standards, or, if not achieved:

- To attain background levels associated with the deep Genuine plume entering the southern portion of the Maple Creek Village Apartments property.

### 1.3.2 Secondary RAOs

To minimize the need for permanent active institutional controls and associated monitoring, sufficient soil and groundwater remediation at the Site is proposed to reduce contaminant concentrations in the aforementioned pathways to relevant cleanup goals such that they remain below these levels without rebound. To achieve these goals, the following Secondary RAOs will also be pursued with the caveat that if:

- the Priority RAOs have been achieved but the following Secondary RAOs have not, and

- any residual hot spots in soil and groundwater have been reduced such that the potential for rebound in the exposure pathways has been adequately addressed,

then, final site closure will be granted by IDEM:

#### 1.3.2.1 On-Site Soil – Michigan Plaza

- Soil at Michigan Plaza will, as needed, be remediated to attain 2012 IDEM RCG soil migration to groundwater (MTG) screening levels, or until IDEM RCG IA C/I screening levels at Michigan Plaza have been achieved with or without an operating vapor mitigation system.

#### 1.3.2.2 On-Site Soil – Maple Creek Village Apartments

- Soil at the Maple Creek Village Apartments will, as needed, be remediated to attain 2012 IDEM RCG soil MTG screening levels, or until IDEM IA residential screening levels at Maple Creek Village Apartments have been achieved with or without an operating vapor mitigation system.

#### 1.3.2.3 On-Site Shallow Groundwater – Michigan Plaza

On-Site shallow groundwater at Michigan Plaza:

- will be remediated, as needed, to attain IDEM RCG Residential VI GWSLs or IDEM RCG IA Residential screening levels, or, if not achieved:

- will be remediated to attain IDEM RCG C/I VI GWSLs with an ERC placed onto the property restricting use of tenant spaces to businesses that would be considered “commercial” in nature and not “residential” in nature (*e.g.*, daycare or after school programs, etc.), or, if not achieved:

- will be remediated to attain IDEM RCG IA C/I screening levels with an active vapor mitigation system verified by periodic sampling and testing required by an ERC placed onto the property, and restricting use of tenant spaces to

businesses that would be considered "commercial" in nature and not "residential" in nature (*e.g.*, daycare or after school programs, etc.).

#### 1.3.2.4 On-Site Shallow Groundwater - Maple Creek Village Apartments

On-site shallow groundwater at Maple Creek Village:

- Will be remediated, as needed, to attain IDEM RCG Residential VI GWSLs or IDEM IA Residential screening levels, or, if not achieved
- Will be remediated to attain IDEM RCG IA Residential screening levels with an active vapor mitigation system verified by periodic sampling and testing required by an ERC placed onto the property.

#### 1.3.2.5 On-Site Deep Groundwater – Michigan Plaza

On-Site deep groundwater at Michigan Plaza:

- will be remediated, as needed, to attain IDEM RCG Residential VI GWSLs or IDEM RCG IA Residential screening levels, or, if not achieved:
- will be remediated to attain IDEM RCG C/I VI GWSLs if an ERC is placed onto the property restricting use of tenant spaces to businesses that would be considered "commercial" in nature and not "residential" in nature (e.g., daycare or after school programs, etc.), or, if not achieved:
- will be remediated to attain IDEM RCG IA C/I screening levels with active vapor mitigation systems verified by periodic sampling and testing required by an ERC placed onto the property, and restricting use of tenant spaces to businesses that would be considered "commercial" in nature and not "residential" in nature (e.g., daycare or after school programs, etc.), or, if not achieved:
- Will be remediated, as needed, to attain background levels associated with the Genuine plume immediately upgradient of the Maple Creek Village Apartments property.

#### 1.3.2.6 On-Site Deep Groundwater – Maple Creek Village Apartments

On-Site deep groundwater at the Maple Creek Village Apartments:

- Will be remediated, as needed, to attain IDEM RCG Residential VI GWSLs or IDEM RCG IA Residential screening levels, or, if not achieved:

- Will be remediated to attain IDEM RCG IA Residential screening levels with active vapor mitigation systems verified by periodic sampling and testing required by an ERC placed onto the property, or, if not achieved:

- Will be remediated, as needed, to attain background levels associated with the Genuine plume immediately upgradient of the Maple Creek Village Apartments property.

However, if these Secondary RAOs have not been fully achieved but the vapor inhalation and off-site groundwater ingestion goals have been achieved and the relevant exposure pathways eliminated or properly addressed, then final site closure will be pursued.

Depending on the actual exposure conditions and chemical trends that are present during active remedial activities, this RWP will also allow for the possibility of performing a site-specific risk assessment in order to select final cleanup objectives that are appropriate for the protection of human health and the environment.

**It should be emphasized that the activities of this VRP are not intended to remediate deep groundwater affected by the Genuine plume migrating below the Michigan Plaza and Maple Creek Village Apartments. As such, an assessment of the groundwater concentrations (and mass flux) coming into the Site from Genuine is essential to determine the ultimate appropriate cleanup goals.**

## 1.4 Remedial Approaches

The selected remediation alternative to address cVOC-impacted groundwater is in-situ bioremediation via enhanced reductive dechlorination at the Site by injecting CAP18 ME® bioremediation product into the subsurface and monitoring the plume groundwater concentrations to ensure that they continue to decrease and achieve the cleanup objectives. CAP18® bioremediation product was injected into the subsurface during two previous rounds, the first occurring between August 1 to September 4, 2007 and the second taking place in February 2009. IDEM approved a third round of injections in June 2013, which was completed in July 2013. A discussion of its implementation is discussed in **Section 3.3.2** of this RWP. Groundwater monitoring activities continue to be conducted on a quarterly basis. Vapor mitigation, soil gas and indoor air monitoring also continue to be conducted.

Depending on the responsiveness of the groundwater and indoor air quality chemical concentration trends to the groundwater remediation injections, additional remedial activity will be considered to treat the remaining residual chlorinated vadose zone soil concentrations in the three chemical source areas. As an optional additional alternative to address lingering adsorbed cVOCs in the vadose zone, MUNDELL proposes application of a mobile Soil Vapor Extraction (SVE) unit to remove additional contaminant mass, thereby reducing the main exposure pathway concern (VI) and minimizing any groundwater rebound of PCE. The SVE system also would have the

added effect of reducing potential leaching to groundwater associated with any smear zone cVOC mass that is flushed during high water periods, or by downward percolating surface recharge in non-paved areas. If selected, the optional SVE activities can begin within three months of IDEM approval.

As an alternative option for supporting the achievement of the Primary RAOs, MUNDELL proposes the use of soil vapor extraction (SVE) methods via a mobile trailer and short-term SVE events to remove cVOC mass from selected areas within the three chemical source areas where vadose soil remains in exceedance of RCG MTG soil screening levels.

Site closure will be demonstrated through two years of quarterly monitoring following the groundwater remediation activities to demonstrate that either cleanup objectives have been achieved, or that the chlorinated solvent plumes (PCE, TCE, cis-1,2-DCE and VC) are stable or decreasing and the soil gas and indoor air cleanup goals have been achieved and that existing and potential exposure pathways have been eliminated. A Remediation Completion Report (RCR) will be submitted once cleanup goals are achieved. An Environmental Restrictive Covenant (ERC) will be recorded stating that the Michigan Plaza property will remain non-residential. Other ERCs and on-site and off-site restrictions may also apply at that time. At the time of site closure, a certificate-of-completion and a covenant-not-to-sue (C-N-T-S) will be sought from IDEM and the Governor's Office of Indiana.

# 2.0 INVESTIGATION ACTIVITIES

## 2.1 Site Baseline Information Summary

### 2.1.1 Geologic and Hydrologic Information Summary

The regional and site-specific surface soils, geology and hydrogeology are described in the following sections. Previous summaries have been provided in various MUNDELL reports associated with the Site. The subsurface aspects highlighted here provide a context for the delineation of chemical impacts found in the soils and groundwater at the Site and the selection and implementation of the appropriate remedial technology for achieving protective cleanup goals.

#### 2.1.1.1 Regional Surficial and Unconsolidated Geology

Marion County is situated within the southern part of the physiographic region known as the Tipton Till Plain, with most of the county underlain by a thick assemblage of glacial deposits located within the White River Basin (see **Figure 3**). These glacial sediments, which include glacial till, randomly arranged ice contact sand and gravel, silt, lake clays, outwash sands and gravel, and alluvial materials, were deposited on a strongly dissected pre-glacial landscape formed on bedrock of highly variable resistance to erosion. The glacial drift cover in Marion County is believed to represent most of the major periods of glaciation that collectively constitute the Pleistocene Ice Age in this area of the United States. The deposits closest to the land surface are generally from the most recent period of glaciation known as the late Wisconsin age, and were formed as a result of several major ice advances into Marion County. The thickness of Wisconsinan glacial drift, which is comprised of loam till of the Trafalgar Formation and some outwash, ranges from 50 to 150 feet in the area (Fenelon et al., 1994).

#### 2.1.1.2 Site Specific Unconsolidated Geology

The U.S. Department of Agriculture Soil Survey of Marion County, Indiana (USDA, 1991) indicates that the Site consists of Urban land-Fox complex with estimated slopes between zero and three percent. The urban land complex indicates that fifty percent of the predominant soil type has been disturbed and has been covered with an impervious layer consisting of buildings, sidewalks, streets and other structures. The undisturbed areas of the complex retain the original soil characteristics. The Fox soils are identifiable in lawns, gardens, parks and other open areas. They have a representative profile of the series, but alteration is evident in many areas where topsoil has been stripped. The Fox soil

series generally consists of nearly level to moderately sloping, well-drained soils that are moderately-deep over sand and gravelly sand. The typical profile for the Fox series is as follows: the surface layer is dark brown loam 8 inches thick. The subsoil is 30 inches thick. The upper 10 inches is dark brown friable loam; the next 6 inches is dark brown, firm sandy clay loam; and the next 14 inches is dark brown, firm gravelly clay loam.

Previous investigations by MUNDELL, Keramida, Environ and the U.S. EPA have advanced over 150 soil borings and installed more than 100 monitoring wells in the vicinity of the Site to define the deeper subsurface geologic conditions (see **Figure 2a**). This information was supplemented with area geophysical surveys including nine (9) 2-dimensional resistivity profile lines that helped to further characterize the conditions between the borings (see **Figure 2b**). Approximately 240 CAP18® injection borings were also advanced as part of the remedial activities in the immediate vicinity of the chemical source areas (see **Section 3.3.2** for further discussion). For purposes of this RWP, **Figure 4** illustrates the locations of selected geologic cross-sectional transects that are depicted on **Figure 5** through **Figure 7.** The descriptions of the subsurface materials were taken directly from the boring logs.

The monitoring well survey information and topographic map data indicate the elevation of the Michigan Plaza site ranges between about 714 and 717 feet above mean sea level (ft-AMSL), while the Apartment site ranges between 710 and 714 ft-AMSL. Based on boring logs completed across the Site and surrounding areas by other consultants, the geology across the project area consists of an inter-bedded and unconsolidated glacial drift sequence of granular deposits and cohesive units. Cohesive soil is commonly present at the surface or near surface, and is in places up to 10 feet in thickness. Sand (with some gravel) is also encountered in places at the ground surface below a thin veneer of topsoil, or below the surficial cohesive soil itself, and generally extends to depths of 30 to 40 ft-bgs. A sand/gravel/cobble zone is commonly present below the discontinuous cohesive soil lenses, at a depth of 25 ft-bgs or more. This unit generally ranges between 20 and 35 feet in thickness.

Laterally discontinuous lenses of clay and silt are encountered within the granular deposits between about El 695 and 670 ft-MSL.

As is observed studying the three selected cross-sections (**Figures 5**, **6** and **7**), a thin (less than 1 to 3 ft thick) fine-grained silty clay layer occasionally appears near El 695 close to the top of the groundwater surface. The upper surface of a more laterally extensive glacial till unit (between about El 675 and 685 ft-MSL) is continuously present below the southern half of the Apartment complex, and extends south below the Michigan Plaza property and Floral Park cemetery. **Figure 8** provides an isopach map of this particular till unit that indicates the variation of its thickness. The area near the Michigan Plaza tend to be thicker

(up to 25 ft) and more consistent, with more significant variations in the till thickness noted directly west and southwest of the Plaza near Holt Road and in the northern portion of the Apartment property. In fact, from Holt Road to the eastern edge of the study area, the till doesn't appear to be as thick; a deeper sand unit has been identified where borings fully penetrate the El 675-685 ft-MSL till unit (*e.g.*, in the MMW-13D-A area). In addition, this till unit also appears to pinch out completely within many portions of the north and northwest apartment complex, north of MMW-13-A and nearest the Genuine site. It also thins to the east toward Little Eagle Creek.

In those areas where a deeper sand body is present, a deeper till unit is eventually encountered below El 655-665 ft-MSL (*e.g.*, see monitoring well MW-WES-05 in **Figures 5** and wells MW-WES-01, MW-WES-03 and RES4018WS in **Figure 7**). The deeper till appears to represent a basal till; shale (consistent with the expected bedrock lithology and depth in this area) was encountered directly below the till in U.S. EPA soil boring MW-WES-01, at El 639 ft-MSL; however, evidence of both shale and limestone sequences was evident in the deeper portionsof the 2-D resistivity profiles.

Based on 2-D resistivity data calibrated to soil boring data, numerous bowl-shaped "pods" and "flow pathways" suggesting possible channels or shallow valleys in their morphology, along with the presence of the coarse-grained (sands, gravels, cobbles) have been identified in the subsurface (see **Figure 9**). MUNDELL has characterized the depositional environment in previous reports as a high-energy fluvial system of braided channels proximal to a melting glacier margin.

### 2.1.1.3 Regional Bedrock Geology

The Site (and Marion County in general) is located within the Tipton Till Plain, a relatively flat glacial plain that extends across central Indiana. The bedrock beneath the unconsolidated deposits in Marion County consists of sedimentary rocks of Mississippian, Devonian and Silurian age. The regional bedrock surface slopes gently to the southwest. Therefore, younger Mississippian rocks are at the bedrock surface in the southwest corner of the county and progressively older Devonian and Silurian rocks are at the bedrock surface in the central and northeast portion of the county, respectively (Harrison, 1963; Fleming et al., 1993).

Bedrock beneath the unconsolidated deposits at the Site is composed of Mississippian and Devonian age New Albany Shale and minor amounts of Mississippian Rockford Limestone. The top of the bedrock surface is estimated to be between EL 625 to EL 650 ft-MSL. The Rockford Limestone of Mississippian age underlies the Mississippian Borden Group. In a bedrock core from Marion County, the Rockford Limestone is a light gray to light brownish-gray

limestone and is about 7 feet (2.1 m) in thickness. It is fossiliferous and is characterized by green mottling (Indiana Geological Survey, 2011). Because the Rockford Limestone is rarely more than 10 ft (3.0 m) thick, it was too thin to map as a separate unit and was mapped with the New Albany Shale in Marion County (Hasenmueller, 2003a, b).

The New Albany Shale of Devonian and Mississippian age underlies the Rockford Limestone and overlies the Devonian carbonate rocks. It consists of brownish-black carbon-rich shale, greenish-gray shale, and minor amounts of dolostone and dolomitic quartz sandstone (Lineback, 1968, 1970; Hasenmueller, 1986). The unit is typically between 110 and 130 feet (33.5 and 39.6 m) thick in the Marion County area (Hasenmueller and Bassett, 1979) and is poorly permeable. It forms the lower part of a thick confining unit that also includes siltstone and shale of the overlying Borden Group (Fleming, Brown, and Ferguson, 2000).

The site is approximately 2,600 feet southwest of the (buried) bedrock contact between the New Albany shale (which the Site overlies) and the Devonian Muscatatuck Group limestone and dolomite (IndianaMap viewer; http://maps.indiana.edu/index.html). However, results from the 2-D resistivity profiles and selected published information (e.g., see **Figure 10**) suggest that the Site may lie in the vicinity of the transition zone between this contact, as intervals of both shale and limestone bedrock appeared to be present near the Site.

As previously described; based on a review of U.S. EPA boring log MW-WES-01 (see **Figure 7**), shale (New Albany) was encountered at approximately elevation 639 ft-MSL.

### 2.1.1.4 Regional Hydrogeology

*General Aquifer Systems*

The White River basin covers an area of 5,603 square miles. The largest river in the basin is its namesake. The largest tributary to the White River is the Eel River, which drains the southwestern part of the basin. Other tributaries include Fall Creek, Eagle Creek, Big Walnut Creek, White Lick Creek, Mill Creek, Pipe Creek, and Cicero Creek (Fenelon and others, 1994). Several streams have been artificially dammed to create water-supply reservoirs, such as Morse, Geist, Eagle Creek, Cagles Mill, and Prairie Creek Reservoirs.

The principal unconsolidated aquifers in the basin are the surficial sand and gravel aquifers - restricted to the major river valleys in the basin - and buried/discontinuous sand and gravel deposits. These were deposited as outwash plain deposits, valley-fill in pre-Illinoian valleys, thin sheets of stratified drift, and small pockets of coarse-grained glaciolacustrine sediment (Watkins and Jordan, 1961; Meyer and others, 1975, Barnhart and Middleman, 1990).

Different types of bedrock aquifers exist in the basin, such as carbonate in the north, siltstone in the central and complex sandstone-shale-limestone-coal aquifers in the south. In the central one-third of the basin (approximately where the Site is located), aquifers are developed in an upper weathered zone of the Devonian and Mississippian New Albany shale and siltstones and shales of the Mississippian Borden Group (Fenelon et al., 1994).

The surface of Marion County consists of Pleistocene glacial deposits and recent alluvial stream deposits. While most of the glacial material in the county consists of fine-grained silts and clay, sand and gravel outwash soils are commonly found along major streams. These outwash deposits, which fill the White River Valley and its major tributaries, were deposited in a complex fashion during what is thought to have been three primary ice advances and subsequent meltwater discharges from ice margins upstream from Marion County (Fleming et al., 2000a,b). The Wisconsin-age sediments, within the White River Valley and a variety of smaller sand and gravel and fine-grained till units are distributed in a discontinuous nature throughout the valley (see **Figure 10**).

### 2.1.1.5 Site Hydrogeology

The Site itself is situated south and west of Little Eagle Creek within an area containing a variable thickness of outwash overlying complexly inter-bedded sand and gravel and fine-grained glacial till (see **Figure 10**). Thick unbroken sections of sand and gravel are present locally, and are typically unconfined within the upper portions of the system, and confined or semi-confined by bodies of glacial till at depth (Fleming et al., 2000a, 2000b). Estimated thickness of the unconfined sand and gravel outwash in the area ranges from 20 to 40 feet on top of an undifferentiated Pre-Wisconsinan glacial till (Brown and Fleming, 2000).

From local experience and published hydrogeologic data in this area (e.g., Meyer et al., 1975; Fleming et al., 2000a,b), shallow regional groundwater levels in the vicinity are expected to range between EL 700 and EL 705 ft-MSL, with groundwater flow from the Site directed towards the south-southeast in the direction of flow in Little Eagle Creek (see **Figure 11**). Based on the interpretation of the results of an east-west oriented two-dimensional resistivity survey completed for the *Phase II ESA* dated May 5, 2005 for the Apartments near the Little Eagle Creek (see additional discussion in Section 2.2.6), there are likely thick, more uniform hydraulically-transmissive sand and gravel deposits east of the Site, deposits that suggest a more proximal position relative to an ice margin braided stream. West of the Site, the well-graded sands appear to have been deposited in a more complex channelized, interwoven and tortuous manner. The depositional environment is inferred to be more distal to the higher energy environment further west, and suggests groundwater flow pathways to be more restricted and less transmissive than those to the east.

**Figure 11** depicts a generalized conceptual site model developed by Fleming et al. (2000) to illustrate the regional potentiometric surface and hydrogeologic settings of the shallow aquifer system in the vicinity of the Site. As indicated, near the major tributaries in this area of Marion County, groundwater flow is always directed toward and in the direction of surface water discharge. This can be seen by the orientation of the potentiometric surface lines in the areas near Little Eagle Creek.

The Site is located in close proximity to Little Eagle Creek immediately to the east and Eagle Creek further to the west-southwest. Little Eagle Creek and Eagle Creek both flow in a general southeast direction until their convergence, approximately 1 mile southeast of the Site. Local groundwater flow is in the southeasterly direction, generally under the hydraulic control and discharge patterns of both Eagle Creek and Little Eagle Creek. Because the Site is immediately west of Little Eagle Creek, that surface water body exerts the most influence on groundwater flow direction at the Site.

Groundwater elevation data from on-site and area monitoring wells have been collected at the Site starting in 2001. Interpretation of these data shows that groundwater flow has consistently been shown in a south-southeast direction, consistent with what would be expected from all regional groundwater flow information.

During flood events in major central Indiana and Marion County rivers and tributaries, the extreme flood surface water profiles occur on the order of less than a few days, with elevated river levels perhaps present for less than a period of two weeks (Arihood, 1982; Cable, 1971; Gillies, 1976; Herring, 1976; Lapham, 1981; Meyer et al., 1975; MUNDELL et al., 1995; Smith, 1983). These flooding periods, because of their relatively short duration, have not reversed groundwater flow direction for periods longer than the flood events themselves (MUNDELL, 1995).

*Water Wells*

MUNDELL reviewed water well records kept by the Indiana Department of Natural Resources (IDNR) for the site vicinity. Low capacity wells listed in the DNR database are shown on **Figure 12**. There are 221 low-capacity wells within one mile of the Site. The high-capacity municipal wells are shown on **Figure 13**. There are 72 high-capacity wells within two miles of the Site. The nearest high capacity downgradient well is greater than 1.5 miles away and is located across Little Eagle Creek. Copies of the IDNR water well logs are provided in **Appendix B.**

Based on IDNR database coordinates, three (3) low-capacity water wells (IDNR Well No. 180590, 54037 and No. 410194) are listed in the database as either

being located at the Site and immediate downgradient vicinity. Well No. 180590 plots on the Maple Creek Village Apartments property, while Well Nos. 54037 and 410194 were reportedly installed on what is now all Floral Park Cemetery property.

A closer review of the information for Well No. 180590 indicates its location is only estimated, and not field verified. Also, the address listed for the well owner places the well on Cossell Road near the intersection with Michigan Street, in the neighborhood to the west of Holt Road. There are otherwise no known water wells utilized in the immediate vicinity of the Site.

Well No. 54037 is associated with the address of 3908 Cossell Rd, located approximately 220 feet south of the southern boundary of the Michigan Plaza and associated with a historic residence at the southern end of the cemetery funeral home parcel. This well was located downgradient to the interpreted groundwater flow direction from the Site in what is now a parking lot for the funeral home. The well was completed in the same aquifer that is being monitored across the Site study area. However, it is noted that the well was likely destroyed, as the residential structure the well is associated with was razed for the funeral home development. There is also no surface evidence of this well.

Well No. 410194 is a listed low-capacity well located at the Floral Park Cemetery, reportedly approximately 400 feet south of the southern boundary of the Michigan Plaza. It was installed for Floral Park in 2007 and is reportedly positioned downgradient of the principal groundwater flow direction. The well was completed in the same aquifer that is being monitored across the Site study area and was reportedly utilized for irrigation purposes. Based on a July 2013 site visit to evaluate the purported area of the well, however, surface features for this well were not identified by MUNDELL.

Cemetery personnel indicated that water used at the maintenance building is connected to a municipal water supply. They also noted that the only water well currently being utilized at their facility was one located near their mausoleum. According to the IDNR records, this would correspond to either well No. 54032 or Well No. 54033, each completed in the aquifer zone of concern. However, based on the investigation completed in the Floral Park Cemetery, these wells are located beyond the extent of dissolved cVOCs associated with the Site.

Based on this review, it does not appear that there are any currently existing water wells located within the footprint of the known dissolved cVOC plume or immediately downgradient of it.

Copies of the INDNR water well logs within a 2-mile radius of the Site are provided in **Appendix B.**

*Groundwater Levels*

**Table 1** summarizes cumulative historical gauging data for the Site monitoring wells across the study area. Groundwater is typically encountered between depths of about 16 to 21 ft-bgs (from about El 695 to EL 699 AMSL) across Michigan Plaza, Floral Park cemetery, and the U.S. EPA well network along and near Holt Road. Groundwater is typically encountered between depths of 10 to 17 ft-bgs across the Maple Creek Village Apartment complex and Michigan Plaza, with the shallower depths noted in wells located adjacent to Little Eagle Creek. Groundwater is in an unconfined setting within the shallow aquifer zone of interest.

**Figure 14** and **Figure 15** depict the most recent groundwater potentiometric surface contours from the second quarter of 2013 monitoring event. As indicated, groundwater flow through Site *Source Areas A*, *B* and *C* is directed to the south-southeast. Since groundwater monitoring began in the area by Keramida in 2001, more than 30 potentiometric surfaces have been generated by water level measurements. In addition, additional potentiometric maps generated by data collected by the U.S. EPA in October 2010 and December 2011 for an area wide study have also been collected. All maps have shown a south-southeast groundwater flow direction through the Site.

*Hydraulic Conductivity Measurements*

During March and April 2013, MUNDELL completed hydrologic (falling and rising head slug) testing on seven (7) monitoring wells between the 2007, 2009 and 2013 proposed CAP 18® injection locations and the Vermont Street Residents area: MMW-P-02, MMW-P-11S, MMW-P-11DR, MMW-P-13S, MMW-P-13D, MMW-P-14S and MMW-P-14D. The results of the 1st Quarter 2013 monitoring and hydrologic testing are provided in **Appendix C**.

The slug testing results, summarized in **Table C1** of **Appendix C** with the analysis provided in **Appendix C**, indicate that the hydraulic conductivity of the upper sand and gravel unit ranged from about 22.1 to 141.1 ft/day, with a representative, mean value of about 70 ft/day. It should be noted that groundwater levels that were displaced temporarily within each monitoring well during the falling and rising head tests were observed to rapidly return to their pre-displacement levels within a few minutes, indicating the responsiveness of the sand and gravel units.

### 2.1.2 Physical and Political Geographic Information Summary

The Site lies in Wayne Township, in the SE ¼, NW1/4 of Section 5, Township 15N, Range 3E. It lies in the Universal Transverse Mercator Zone 16. The UTM coordinates are as follows:

UTM X (Meters): 566,254.8
UTM Y (Meters): 4,402,704.0

The Site is located approximately 350 feet east the intersection of West Michigan Street and Holt Road in Indianapolis, Indiana. The topography of the Michigan Plaza property slopes slightly downward from the building area out to the property boundary, with generally no more than 3 feet of surface elevation change moving away from the building. Surface elevation in the central portion of the Site is approximately 716 to 717 ft-AMSL, while the surface elevation at the edges of the site is typically at 714 to 715 ft-AMSL.

The topography of the Apartment complex property slopes downward slightly from south to north, with approximately four feet of surface elevation change from Michigan Street to Little Eagle Creek. Surface elevation in the southern portion of the Site is approximately 714 ft-MSL, while the surface elevation at the northern edge of the site is 710 ft-MSL along the southern bank of Little Eagle Creek. Holt Road, west of the western boundary of the Site, appears to be built up relative to surrounding land and is in places up to 6 feet higher than the surface of the Apartment complex.

Surrounding properties for the Plaza property include Michigan Street followed by the apartment complex to the north, an open field (that includes a set of high voltage transmission lines) to the east, Floral Park cemetery to the south, and private residences located to the west, followed by Holt Road and additional residential properties.

Surrounding properties for the Apartment complex property are Little Eagle Creek followed by the former Genuine Parts facility (now utilized by Asset Recycling) to the north, Little Eagle Creek followed by mainly residential and isolated commercial properties to the east, Michigan Street followed by Michigan Plaza to the south, and Holt Road followed by residential properties to the west.

An adjacent properties map is provided as **Figure 16**.

### 2.1.3 Identification of Susceptible Areas

The city of Indianapolis supplies drinking water and sewage service to the Site. As mentioned above in *Section 2.1.1*, forty-three (43) high-capacity wells are located within two miles of the Site. The nearest downgradient high-capacity well is approximately 4300 feet to the south, across Eagle Creek along West Washington Street.

The Site is not located within a Marion County wellhead protection area (Refer to Appendix F, Phase I Environmental Site Assessment, MUNDELL, December, 2003). The Site is, however, located within one of seven designated Marion County Health Department (MCHD) No Well Zones (NWZs). Since the MCHD requires permits for all

water supply wells in the county, the purpose of the NWZs designation is to provide short-term protection of human health until the impacted groundwater is remediated by responsible parties. This designation in the area of the Site currently supports the likelihood there will be no future potable wells in close proximity to the Site. However, it is understood that residential areas to the west and southwest (across Holt Road) utilize private drinking water wells.

A daycare facility (Kids X-Clusive) is located in the 3807/3809 West Michigan Street tenant space of Michigan Plaza. Stephen Foster Elementary School is located approximately 0.3 miles northeast of the Site.

Various grasses and forbs such as goldenrod (*Solidago* sp.), ragweed (*Abrosia* sp.), and other weedy species are present in the area. Animal species observed in this area include red-winged blackbirds (*Agelaius phoeniceus*), raccoons (*Procyon lotor)*, and opossum (*Didelphis marsupialis*). A mature deciduous woodland habitat extends to the banks of Little Eagle Creek. Tree species present in this woodland include sycamore (*Platanus occidentalis*), cottonwood (*Populus deltoids*), and other deciduous tree species. This wooded area grades steeply down to the creek. The woodland canopy is dense along the creek while the understory is sparse. Animal species observed in the wooded area include abundant bird populations, raccoons (*P. lotor*), and opossum (*D. marsupialis*).

Great blue herons (*Ardea herodias*) have been observed along the edges of the creek, although no fish have been noted in the water.

The U.S. Fish and Wildlife Services (USFWS) was contacted for information on state or federally-listed threatened and endangered species (TES), rare species, and critical habitats that are known to occur in the Site area. The USFWS response is included in **Appendix D.** Also, IDNR reported that no plant or animal species listed as state or federally threatened, endangered, or rare have been reported in the Site vicinity.

The USFWS reported the Site is within the range of the federally endangered Indiana bat (*Myotis sodalis*) and the federally threatened bald eagle (*Haliaeetus leuindicator compoundephalus*). *M. sodalis* nests in woodlands during the summer months, selecting trees with loose bark for nest sites. They forage for insects primarily over wooded stream corridors, although they have also been documented as using other habitats for foraging. *M. sodalis* have been documented in northeast Marion County and in Hendricks County in Indiana. Based on this information, the wooded area of the Site and Little Eagle Creek are potential nesting and foraging habitats for the Indiana bat.

*H. leuindicator compoundephalus* nest in close proximity to lakes, rivers, or other large surface water bodies, constructing their nests near habitat ecotones such as lakeshores and cuts within timber management areas. The West Fork White River in Morgan County, Indiana is primary wintering area for *H. leuindicator compoundephalus,* where food sources such as waterfowl and fish are available.

The Kirtland's snake (*Clonophis kirtlandii*), a species of concern, may also be present in the general Site area. Although *C. kirtlandii* is not federally threatened or endangered, the USFWS and other federal and state agencies encourage consideration of this species in project planning. Finally, the USFWS noted the potential for migration of contaminants to Little Eagle Creek and nearby wetlands, with potential bioaccumulation and/or toxic effects in aquatic media organisms.

The National Wetlands Inventory (NWI) map indicates that there may be riverine wetlands (associated with Little Eagle Creek) within and adjacent to the area of interest. Water and other habitat resources are attractive to numerous wildlife species. In particular, migratory birds such as wood ducks (*Aix sponsa*), mallards (*Anas platyrhynchos*), and tree swallows (*Tachycineta bicolor*) will utilize open water wetlands and are subject to potential impacts from contaminants.

Little Eagle Creek is a perennial stream that flows in a south-southeasterly direction in the vicinity of the Site and is the principal surface water feature in the area. It originates approximately eight miles north of the Site and discharges to Eagle Creek southeast of the Site. A 100-year flood zone exists within 1/8$^{th}$ of a mile to the north-northeast side of the Site. A 500-year flood zone is identified at approximately 1/4$^{th}$ of a mile to the south-southwest side of the Site. The groundwater flow from the site is generally towards the south-southeast in the direction of flow in Little Eagle Creek.

Karst bedrock areas are not known to exist in the vicinity. Copies of the letters received from IDEM, IDNR, MCHD, IGS, and USFWS are included in **Appendix D**.

### 2.1.4 Summary of Historic Water and Chemical Use on Site

The MUNDELL *Phase I ESA* dated December 29, 2003 indicated the historical existence of a dry cleaners on-site (Accent Dry Cleaners: 3819 W. Michigan Street - Michigan Plaza) that is associated with a certain amount of environmental impact at the Site due to the past use of hazardous substances (*i.e.*, PCE) from the previous dry cleaning operations. Other historic commercial businesses were noted to have stored only small quantities of chemicals for their operations (*e.g.*, a pest control service stored small amounts of herbicides and pesticides). There is no longer PCE storage at this unit; it is currently operating as a place of worship. There are typical household cleaning items in the various tenants in the Plaza units, none of which are considered to present significant environmental hazards.

Of note, the exterior area north of the 3801 tenant space is being considered for development as a fuel dispensing station. The area is currently (September 2013) being reviewed for zoning considerations.

## 2.2 Site Environmental Investigation Summary

MUNDELL initiated site investigations in 2001 and groundwater monitoring activities in 2004. MUNDELL has conducted quarterly sampling activities since the second quarter of 2007. The monitoring well network has been expanded over the years in order to provide additional information at the Site and surrounding areas. Each quarter, MUNDELL has gauged groundwater monitoring wells and sampled and analyzed for cVOCs. Select wells are also analyzed for various natural attenuation parameters, including total organic carbon, iron, sulfate, nitrogen, methane, ethene, and ethane. Since the first round of CAP18® injections, MUNDELL has tracked various geochemical parameters in the wells to monitor subsurface conditions for in-situ remediation.

Quarterly sampling events also consist of collecting air samples from the seven (7) air mitigation systems installed between September 2006 and March 2008. Annual groundwater sampling events include the same quarterly protocol in addition to the gauging and sampling of eight (8) other monitoring wells along the northern property line of the Maple Creek Village Apartments. MUNDELL conducts air sampling at the six units within Michigan Plaza, as well as within Maple Creek Village Apartment Building Nos. 1, 6, and 10.

The results from these groundwater and air sampling events, along with the results from a number of other subsurface investigations in the Site area, have been important in developing the selected remedial methods. Summaries of the cumulative historical analytical results are provided in **Table 2** for soil, **Table 3** for groundwater**, Table 4a** and **Table 4b** for indoor air (Michigan Plaza and Apartments, respectively), **Table 4c** for soil gas, **Table 5** for mitigation system air sampling, **Table 6** for surface water, and **Table 7** for grab water and sewer sampling**.**

**Figure 17a, Figure 17b,** and **Figure 18** depict the most recent groundwater analytical results from the 2Q13 monitoring event.

**Figure 19** depicts historic surface water sampling locations.

Cumulative historical soil investigation locations and analytical testing results are also illustrated in **Figure 20a** (north of Michigan Street) and **Figure 20b** (south of Michigan Street). A geophysical survey transect map is provided as **Figure 2b**. Boring logs from soil investigations and well installations are provided in **Appendix E**.

The following sections present a synopsis of activities, results and conclusions from previously prepared documents. Pertinent events that occurred during the various investigative and remedial activities are also provided in the summaries.

### 2.2.1 MUNDELL Indoor Air Testing - December 2001

MUNDELL was retained by Bose McKinney and Evans (BM&E) in late 2001 to review studies conducted by Keramida Environmental (Keramida) as part of an IDEM VRP investigation at the former GM AGT Plant 10 facility located north of the Apartments and Plaza. Investigations of that facility indicated groundwater impacts had apparently moved offsite and to the south beneath what was then the Michigan Meadows Apartments and Michigan Plaza. Of special concern was the evaluation of potential impacts to indoor air quality at the Apartments that could cause a human health concern to the current residents.

Indoor air sampling performed by MUNDELL on December 10, 2001 detected the presence of VOCs at low concentrations in several apartment buildings basement areas in the northwestern portion of the Apartments property nearest the former GM facility, over the most severely impacted portion of its associated groundwater plume.

### 2.2.2 Keramida Phase II Investigation - March 2002

As a part of the *Phase II* investigation for the 2002 *RWP* associated with the Genuine Site (Keramida, 2002 a, b, c), Keramida conducted off-site subsurface sampling for VOCs, including testing at 3800 through 3823 West Michigan Street and the surrounding areas. Groundwater samples taken by Keramida from both the shallow and deep groundwater systems in the area indicated chlorinated solvent groundwater impacts (most notably cis-1,2-DCE and VC) beneath the Plaza (refer to MUNDELL *Phase I ESA*, December 2003). These *Phase II* results, summarized on groundwater analytical maps, established a clear connection between the groundwater contamination found at the former GM AGT Plant 10 facility and the groundwater contamination detected beneath the Apartments and the Michigan Plaza.

### 2.2.3 Keramida October 2002 RWP and August 2004 RWP

In October 2002, Keramida submitted a *RWP* to IDEM VRP that outlined its plans for the remediation of the former GM AGT Plant 10 facility. In August 2004, Keramida submitted a revised *RWP* based on comments received by IDEM. Both *RWPs* depicted groundwater flowing south from the former GM AGT Plant 10 facility to the Apartments and Michigan Plaza, and demonstrated that the former GM AGT Plant 10 facility is directly (hydraulically) upgradient of the Site and the likely sole source of groundwater impacts beneath most of the Apartments property and a contributing source to the Michigan Plaza property.

### 2.2.4 MUNDELL Air Quality Study - April 2003

Based on the December 2001 MUNDELL indoor air testing results, along with a review of the subsurface investigations and remediation conducted by Keramida as part of VRP

activities for that site, the cumulative data raised a concern that additional investigations at the Apartments and the Michigan Plaza were warranted to further define the severity of groundwater impacts, and the resulting potential impact on indoor air quality for the facilities. In response, MUNDELL completed a more comprehensive indoor air quality investigation in April 2003 designed to detect potential impacts at the Site that could pose a human-health concern to the current residents and tenants. Air samples were collected from twenty-three (23) Michigan Meadows Apartments buildings (Building Nos. 1 through 23) and four (4) tenant units (3801, 3805, 3815 and 3817 West Michigan Street) at the Michigan Plaza Shopping Center. Five soil gas wells (MGW-01 through MGW-05) were also installed across both properties and sampled.

The results of this investigation were summarized in an *Air Quality Investigation Report* dated June 9, 2003 that indicated that indoor air samples from tenant units in Michigan Plaza Shopping Center were above the draft U.S. EPA guidance indicator indoor air concentrations and the existing IDEM draft guidance default concentrations for PCE and TCE. A map depicting cumulative historic indoor air results from sampling at the Site is provided as **Figure 21**, and a map depicting cumulative soil gas results is provided as **Figure 22**.

### 2.2.5 MUNDELL Phase I ESA - November 2003

On July 1, 2003, IDEM issued a response letter after review of MUNDELL's June 2003 *Air Quality Investigation Report*. IDEM stated that it did not believe the information presented indicated an imminent health threat requiring immediate action to relocate businesses or other immediate abatement action. IDEM did feel that the report indicated the potential for a vapor intrusion problem at Michigan Plaza, and that further investigation was prudent.

Subsequent to the April 2003 indoor air study, MUNDELL performed a detailed *Phase I Environmental Site Assessment* (ESA) of the Michigan Plaza site in November 2003. The associated *Phase I ESA* report dated December 29, 2003 indicated the historical existence of a dry cleaners on-site (Accent Dry Cleaners: 3819 W. Michigan Street - Michigan Plaza) that posed a potential environmental concern for the Site due to the past use of PCE from the previous dry cleaning operations. It also indicated the presence of known groundwater impacts in the area and other areas of off-site environmental concern, including groundwater impacts from the former GM AGT Plant 10 facility located north of the Site. Based on the *Phase I ESA* findings and conclusions, MUNDELL recommended the advancement of additional soil borings and groundwater sampling on the Site in the vicinity of the former dry cleaners to determine potential impacts from the former operations.

IDEM issued a letter dated August 3, 2004 that requested an Initial Site Characterization (ISC) study.

### 2.2.6 Geophysical Study - August 2004

MUNDELL performed geophysical field activities on August 19, 2004. The primary goal of the study was to image stratigraphic interrelationships between 2-dimensional resistivity imaging calibrated to drilling observations from borings/wells in order to identify primary transport pathways through the upgradient site boundary as well as the base elevation variation of the upper sand and gravel aquifer system. This information assisted in locating monitoring well screens for evaluating cVOC concentration variations as well as determining the presence of potential Dense Non Aqueous Phase Liquid (DNAPL) accumulations near the base of the aquifer from the Genuine Site. The resistivity survey was conducted along the northern boundary of the apartment complex, roughly parallel to Little Eagle Creek. MUNDELL subsequently presented the results of the geophysical survey in its *Phase II Environmental Site Assessment* report dated May 5, 2005.

### 2.2.7 MUNDELL Phase II Investigation – Michigan Plaza, August 2004

MUNDELL undertook assessment activities at Michigan Plaza in August 2004. The on-site activities included completion of five (5) Geoprobe™ soil borings (GP-01, GP-02, GP-03, GP-04 and GP-05), all of which included soil and groundwater sampling and testing. In addition, air sampling (indoor air, soil gas wells, and below slab) was performed by MUNDELL as a part of this site investigation. The boring locations would subsequently be installed with permanent monitoring wells (MMW-P-01 through MMW-P-05) in late 2005.

Two cVOC chemicals, PCE and cis-1,2-DCE, were detected in soil samples taken from above the groundwater table at the Site. None of the soil samples collected had cVOC concentrations above their respective 2009 IDEM RISC Default Commercial/Industrial cleanup levels. Detectable levels of nine VOCs (PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, chloroform, vinyl chloride, methylene chloride, toluene and acetone) were observed in the groundwater collected beneath the Site. Groundwater samples tested from three (3) of the five (5) boring locations contained detectable levels of PCE above the 2009 IDEM RISC Default Residential closure level. The most elevated PCE levels were observed behind and immediately downgradient of the former dry cleaning facility space within the Plaza building. These PCE concentrations exceeded the 2009 IDEM RISC Default Industrial closure levels at this location, and ranged from a maximum of 730 ug/L at a depth of 20 ft bgs (within one foot of the top of the groundwater table) to 11 ug/L at a depth of 40 ft bgs (about 20 feet below the top of the groundwater surface).

MUNDELL provided this data in a *Phase II Report* for Michigan Plaza dated February 16, 2005, which was submitted to IDEM.

### 2.2.8 MUNDELL Phase II Investigation – Apartments, Aug/Sept 2004

In August and September 2004, MUNDELL undertook a separate *Phase II Environmental Site Assessment* study along the northern portion of the Apartment property which included the installation of seven groundwater monitoring wells (MMW-1S, MMW-2S, MMW-3S, MMW-4D, MMW-5D, MMW-6D and MMW-7S) with soil and groundwater sampling, and testing of surface water at three locations along the creek as it passes by the Genuine site and the apartment complex. The results indicated cVOC impacts (TCE, cis-1,2-DCE and VC) migrating onto the property from the former GM AGT Plant 10 facility. PCE and TCE detections were also identified in soil and groundwater in the vicinity of MMW-1S.

Two out of the three surface water samples exhibited detectable concentrations of cis-1,2-DCE during the September 2004 sampling event. The adjacent sample to the Genuine site (MSW-2) and the downstream sample (MSW-3) exhibited cis-1,2-DCE concentrations of 12 ug/L and 9.6 ug/L, respectively. These results were consistent with the results reported in the Keramida *Phase II Investigation Report*, March 2002. The sampling was conducted in a low-flow period, which should reflect a 'worst case' scenario with respect to the expected concentrations resulting from impacted groundwater discharge from the former GM facility into Little Eagle Creek.

MUNDELL described the results of the work in a *Phase II Report* for the Apartments (dated May 5, 2005), which was submitted to IDEM.

### 2.2.9 MUNDELL Air Quality Study - October 2004

MUNDELL conducted another round of air sampling in October 2004 that included sampling of the highest PCE/TCE air concentration tenant units (Nos. 1 and 20) at Michigan Meadows Apartments and Michigan Plaza Shopping Center. Air samples were collected at Buildings Nos. 1 and 20 and in two of the tenants of Michigan Plaza (3815, 3819). In addition, one below-driveway slab air sample was collected behind what was at the time a Mexican grocery store in the Plaza (unit 3819), and from the unsaturated soil zone of three of the soil gas monitoring wells (MGW-01, MGW-03, MGW-05).

As indicated by the air results, concentrations of PCE, TCE, cis-1,2-DCE, and vinyl chloride were detected in all eight indoor air samples taken at the Site, and also in the three (3) ambient air samples obtained at the Apartments property. The highest indoor air concentrations of PCE and TCE at the Apartments were 46 ug/$m^3$ in Building No. 1 (basement apartment) and 2.1 ug/$m^3$ in Building No. 20 (third floor apartment), respectively. Higher concentrations of PCE (120 to 180 ug/$m^3$) were detected within the two tenant units at the Michigan Plaza Shopping Center; above both the current draft U.S. EPA guidance indicator indoor air concentrations and the IDEM draft default concentrations for PCE.

The samples collected from the gas wells located on the Apartments property (MGW-01 and MGW-03) exhibited PCE, TCE, cis-1,2-DCE and VC concentrations of the same magnitude or less than the ambient air samples collected from the property, indicating soil gas concentrations that do not appear to be elevated relative to the general above-ground, ambient air.

The highest soil gas concentrations of PCE (1400 ug/$m^3$), TCE (3900 ug/$m^3$), and cis-1,2-DCE, (2,900 ug/$m^3$) were detected in MGW-5 located north of the Plaza building. These levels far exceeded the observed ambient air results, and indicated potential subsurface soil and/or groundwater impacts at the site by either past on-site operations or a previous, unknown chemical release event that has occurred. Elevated soil gas concentrations of PCE and TCE above ambient air levels detected in the below pavement slab sample (and duplicate) taken immediately behind the Plaza building further suggested potential sources of subsurface impact beneath the Plaza property.

Results were included in an *Air Quality Investigation Report – October 2004*, dated April 4, 2005. During this timeframe, IDEM issued a *Special Notice of Liability and Requirement for Interim Response* letter dated February 9, 2005.

### 2.2.10 Geophysical Survey and Anomalies Investigation - February 2005

MUNDELL conducted a geophysical survey on February 18, 2005 using electromagnetic techniques (Geonics EM61 and EM38) in order to map on-Site subsurface features at the Michigan Plaza to aid in the identification of potential on-Site chemical source areas and release pathways. Results of this survey prompted test pit excavations in three locations – discussed in Section 2.3. An associated report dated July 20, 2005 summarizing the work was subsequently included as an appendix within MUNDELL's *Further Site Characterization Repor*t, dated May 10, 2006.

### 2.2.11 MUNDELL Test Pits Investigation – Michigan Plaza, April 2005

Based on the above-referenced geophysical survey conducted on February 18, 2005, test pit excavations were conducted on April 27, 2005 in three locations, one of which (test pit TP-3) was immediately south and behind the former location of the dry cleaners. In TP-3, a sewer line was confirmed and soil sampling revealed PCE concentrations above residential but below industrial IDEM RISC Default Closure values. The findings were summarized in a *Geophysical Survey and Anomalies Investigation* report dated July 20, 2005. These results helped guide the subsequent further site investigation (FSI) activities.

### 2.2.12 MUNDELL FSI – Michigan Plaza, Sept/Dec 2005

MUNDELL conducted FSI activities at the Site between September and December 2005 to confirm an on-site chemical source at Michigan Plaza, and to delineate chemical

impacts to soil and groundwater from past Site operations. On the Michigan Plaza property, three (3) Geoprobe™ borings were advanced (GP-06, GP-07 and GP-08), six (6) shallow monitoring wells were installed (MMW-P-01, MMW-P-02, MMW-P-03S, MMW-P-04, MMW-P-05 and MMW-P-06), and one deep monitoring well was installed (MMW-P-03D).

On the Apartments property, five (5) Geoprobe™ borings were advanced (GP-A-01, GP-A-02, GP-A-03, GP-A-04 and GP-A-05). GP-A-01 and GP-A-02 were placed along the north-south sewer connector, while GP-A-03, GP-A-04 and GP-A-05 were placed immediately north and in the vicinity of the east-west sewer line where it connects with the Michigan Plaza sewer line crossing Michigan Street. Soil samples were collected from borings GP-A-01, GP-A-02, and GP-06.

MUNDELL also performed further sewer line investigation in September and November 2005 by collecting liquid samples from five different sewer locations running along Michigan Street, which showed detectable concentrations of PCE. A video-taping camera was also used inside sewer locations to identify cracked/worn out joints and offset.

MUNDELL also conducted a follow up indoor air sampling event in September 2005, which included sampling of the prior highest PCE/TCE concentration units at the Plaza. The results of all these activities were included in a *Further Site Characterization Report* dated May 10, 2006 which was submitted to IDEM. Sewer lines were identified as a subsurface contaminant transport pathway contributing to groundwater contamination, primarily of PCE in shallow groundwater in three distinct *Source Areas (A, B* and *C*) at the Site.

### 2.2.13 MUNDELL FSI Activities – Michigan Plaza, Sept 2006 - Feb 2007

In response to the May 2006 *Further Site Characterization Report*, IDEM issued a letter dated August 2, 2006. The letter summarized various comments from technical reviewers, and indicated that the horizontal and vertical extent of contamination associated with the Michigan Plaza needed further delineation to better characterize the role the Michigan Plaza related release had on the soil, water, and air impacts. Also, IDEM requested indoor air abatement at the Plaza and additional sewer investigation information.

In response, MUNDELL performed additional FSI activities between September 2006 and February 2007 to address outstanding concerns regarding the existence and extent of potential releases of the PCE and TCE from the sewer line connected to the Michigan Plaza (primarily in *Source Area B* and *Source Area C*), to delineate downgradient extents of impacts from the Plaza (*Source Area A*), and to evaluate if Site releases could impact the ecological health and surface water quality and biota in Little Eagle Creek.

In September 2006, air mitigation systems were installed by Air Quality Control, Inc. in four (4) units at Michigan Plaza (Units 3801, 3815, 3819, and 3823). A summary of this work is provided in the *Indoor Air Mitigation System Installation Report - September 2006* dated September 29, 2006 that was submitted to IDEM. Air mitigation system locations are depicted on **Figure 23**. Figures depicting cumulative mitigation system contaminant trends are provided as **Figures 24a through 24i** (for PCE) and **Figures 25a through 25i** (for VC).

In January 2007, MUNDELL advanced several shallow soil borings in close proximity of the sewer line relative to sewer invert SS-A-1 in the upflow direction (Geoprobe™ locations GP-A-06, GP-A-07, GP-A-08, and GP-A-09) and advanced several borings and converted them into monitoring wells in the downgradient direction in *Source Area B* (MMW-8S, MMW-P-07 and MMW-P-08) and *Source Area C* (MMW-9S and MMW-10S). Additional vertical groundwater profiling (depths of 20, 30 and 40 ft-bgs) was also performed in these locations, positioned to be downgradient of the suspected sewer release areas. Each boring was probed under the direction of MUNDELL personnel using a truck-mounted Geoprobe Model 6610 drill rig. IDEM staff was present on Site on January 11, 2007 to witness the event.

MUNDELL performed additional soil and groundwater sampling downgradient of *Source Area A* by advancing Geoprobe™ borings near the intersection of Cossell Road and Olin Avenue (GP-C-01, GP-C-02, GP-C-03, GP-C-04 and GP-C-05), and then installed and sampled a shallow monitoring well at that intersection (MMW-P-09).

In order to investigate the potential for ecological impact to surface water and biota in the Little Eagle Creek, MUNDELL undertook surface water sampling on February 21, 2007 at three (3) locations on the Little Eagle Creek meandering east of the Michigan Plaza site, one upstream (MSW-1) of the Michigan Plaza PCE release areas, and two downstream (MSW-2 and MSW-3). The analytical results for the contaminants of concern were below method detection limits for all VOC indicator compounds at each of the locations. Results of these activities are summarized in detail in the MUNDELL *Further Site Investigation Addendum I* report dated April 1, 2007 (MUNDELL, 2007a).

Based on the results of the *FSI Addendum I* study, MUNDELL drew the following conclusions:

- Releases of PCE and TCE from the sewer appeared to be confined to the south-central (*Source Area B*) and south-eastern (*Source Area C*) locations of the Apartments property previously indicated in the *FSI*, and were not detected in the western portion.

- The horizontal extent of PCE releases associated with the east-west sewer line system and connected piping were consistent with the previous *FSI* results and indicate PCE releases in areas near sewer line system intersections and joint locations as previously determined. The vertical extent of these releases appeared

to be most severe in the shallow, upper 10 feet of the saturated aquifer, with lesser impacts observed at depths of up to 40 ft-bgs.

- Flow in the east-west sewer line comes from the west and flows to the east. Because of the hydraulic line of the sewer flow (as also documented by measured sewer invert elevations), only under some kind of extreme sewer backflow event could flow from the former Accent Cleaners move even slightly to the west. This investigation of the very next north-south sewer connection to the east-west leg indicated no leakage of PCE/TCE had occurred there. These observed conditions indicate that the solvent releases that did occur from the Site did not travel west of the intersection of the Michigan Plaza sewer within the east-west sewer leg, and were only found in three very distinct release locations.

- Initial groundwater sampling and testing downgradient of the Michigan Plaza indicated that detectable PCE impacts may extend in a limited fashion as far south as the intersection of Cossell Road and Olin Avenue (note: this conclusion has since been refuted, as subsequent analytical data from each quarterly monitoring event since the 2$^{nd}$ quarter 2007 has shown PCE does not extend to this area).

- Based on the non-detect results of the surface water testing performed on Little Eagle Creek, there did not appear to be any significant potential for ecological impact to the biota or the surface water in the Creek at that time.

- Groundwater sampling results also indicated there are chemical impacts within the deeper portion of the upper aquifer which are likely from further upgradient releases from the Genuine Site north of the Apartments. As such, there are limited zones of co-mingled chemical compounds (specifically cis 1,2-DCE and VC).

- MUNDELL concluded that sufficient further site investigation had been completed to allow for the development of a RWP.

During this phase of activities, the following additional events took place.

Representatives from MUNDELL, AMMH and IDEM held meetings on October 17 and December 14, 2006 to discuss vapor intrusion, the sewer investigation, the extent of contamination, and potential co-mingling concerns associated with the Genuine site. On December 14, 2006, AMMH submitted an application to enter the Site into the VRP. IDEM issued a letter dated December 19, 2006 that summarized the recent meetings associated with further site investigations to characterize the soil and groundwater contamination in the vicinity of Michigan Plaza.

In a letter to AMMH dated January 11, 2007, IDEM accepted the Site into the VRP. IDEM and AMMH entered into a Voluntary Remediation Agreement (VRA) on April 20, 2007.

Following review of MUNDELL *FSI Addendum I* report, in a letter dated May 4, 2007, IDEM indicated that:

1) The shallow contaminant plume had been sufficiently delineated for the purpose of remedial planning; and

2) Vertical delineation on-site and off-site was required.

### 2.2.14 MUNDELL FSI Activities May - June 2007

Based on a meeting held with MUNDELL, AMMH and IDEM on May 25, 2007**,** it was agreed that deeper monitoring wells (approximately 35 to 50 feet deep) would be installed near monitoring wells MMW-8S, MMW-P-07 and MMW-P-08 and downgradient of MMW-P-03D to further delineate and monitor the extent of impacts from chemical source *Areas A*, *B* and *C*. A RWP outline was also discussed with IDEM at the meeting.

As a result, further site characterization and groundwater sampling activities were performed in May and June 2007, the details of which are documented in MUNDELL'S August 15, 2007 *Quarterly Monitoring Progress Report – 2nd Quarter 2007*, Michigan Plaza (MUNDELL, 2007C). Four (4) additional permanent monitoring wells (MMW-11S, MMW-P-10S, MMW-P-10D, and MMW-P-09D) were installed from May 31 through June 1, 2007**.** One soil sample was obtained from MMW-P-10S.

Based on sampling results, adsorbed PCE was reported in exceedance of IDEM RISC RDCLs at MMW-P-10S. Several wells sampled reported cVOCs in exceedance of relevant RISC IDCLs. The quarterly report also summarized the planned CAP18® injection activities, proposed for (and subsequently completed in) August 2007. The 2007 CAP 18® injection locations are depicted on **Figure 26a.**

### 2.2.15 Soil Investigation during Sewer Tie-In Construction – October 2007

Tie-in to the sewer system on the north side of the Plaza property was undertaken by others on October 1, 2007. This included the construction of a new sewer line connection to the existing manhole at the bend of the sewer line which travels from the south to the north side of Michigan Street. MUNDELL was present during the excavation activities to observe the general soil conditions and sample the soils. MUNDELL obtained one soil sample from the backhoe bucket at a shallow depth (approximately 4 ft-bgs) which contained 0.243 mg/kg of PCE (above 2009 RISC RDCL for soil). MUNDELL also obtained one deeper soil sample with a stainless steel hand auger immediately adjacent and below the invert of this manhole (approximately 9 ft-bgs). This sample contained a PCE concentration of 2.3 mg/kg (above the 2009 RISC IDCL for soil). Deeper soils aside from the samples referenced were not removed, as the utilities surrounding the manhole prohibited such activity.

### 2.2.16 Air Mitigation System Installation, RWP, Wells - 2008

MUNDELL oversaw the installation of air mitigation systems in March 2008 in Apartment Units 101 (Building No. 1), 602 (Building No. 6) and 1001 (Building No. 10). The activities were later summarized in the *Response to IDEM Comments to the RWP* document dated September 25, 2008.

MUNDELL submitted a *RWP* dated February 22, 2008 to address the remediation of the Site. This 2008 RWP proposed the use of in-situ bioremediation using sequential reductive dechlorination as the prime remediation alternative. IDEM subsequently issued a RWP review letter dated May 27, 2008. The letter included seventeen (17) specific comments that required a response as part of a revised RWP. An IDEM Brownfields Program letter dated July 31, 2008 was also issued that provided specific comments associated with the Apartments. The Program was in general agreement with the May 27, 2008 RWP review letter, indicating that vapor mitigation systems needed to be installed in Apartment Building Nos. 1, 6, and 10, that indoor air sampling should be completed, and an annual vapor sampling plan needed to be submitted for approval.

MUNDELL provided responses to the IDEM comments in a *Response to IDEM Comments to the Remediation Work Plan* letter dated September 25, 2008, the content of which would also ultimately be incorporated into a revised RWP.

IDEM submitted a *Remediation Work Plan Response to Comments and Addendum I Review* letter dated November 17, 2008. The letter provided eleven (11) follow-up comments pertaining to shallow versus deep contamination, the extent to which deep aquifer contamination may be present, requirements of additional monitoring points, and needed clarification regarding the source of indoor air contamination.

Between November and December 2008, MUNDELL installed four (4) additional monitoring wells at the Apartments (MMW-11S, MMW-12S, MMW-13D, and MMW-14D).

### 2.2.17 Additional Sampling and Remediation – Various Dates, 2009

*Additional Delineation - Source Areas A and B*

MUNDELL completed additional site characterization beneath the Michigan Plaza building in *Source Area A* (Unit 3819, the (then) Zacatecas Mexican grocery store) where the dry cleaning equipment had been historically located. MUNDELL oversaw the advancement of ten (10) soil borings between February 3rd and 5th, 2009. Seven soil borings (SB-01 through SB-07) were advanced beneath the plaza building to define the extent of soil and groundwater impacts in *Source Area A*. Three (3) soil borings (SB-08 through SB-10) were advanced on the south side of the Plaza building. A mobile laboratory (Sierra Mobile Lab) was used for real time results which aided in delineating the extent of the soil impacts. This enabled instantaneous turnarounds on

soil/groundwater samples to be able to guide the subsequent CAP-18$^{ME}$ injection locations that also occurred with those interior borings.

Seven (7) soil borings (SB-11 through SB-17) were also advanced in *Source Area B* for additional characterization of contaminants emanating from the sewer line. The drilling in Source Area B was performed the week of February 9, 2009. Shallow grab groundwater samples were also collected at select boring locations for laboratory analytical testing using dedicated disposable plastic tubing placed inside the groundwater sampling probe.

Based on the results of the boring sampling and testing, PCE was identified in exceedance of the IDEM IDCL at SB-03 and SB-04 in *Source Area A*. PCE was also identified in exceedance of the IDEM RDCL at SB-08 and SB-10. In ***Source Area B***, PCE was identified in exceedance of the IDEM IDCL at SB-11, SB-12, SB-13, SB-14, SB-15, and SB-17. PCE was identified in exceedance of the IDEM RDCL at SB-16. Most of the impacts were noted just downgradient of the sewer joints (*e.g*., in borings SB-12 and SB-13 downgradient of the sewer joint south of Michigan Street and in SB-14 and SB-17 just downgradient of the sewer joint north of Michigan Street.

*Additional CAP18 Injection: Second Round*

The overall results from the 1st Injection Round of CAP18® injection performed in August 2007 were encouraging; the 2nd booster round of injection was scheduled to aggressively treat some areas where the chemical concentrations were stable or just slowly decreasing. The second round of CAP18 ME® injection, verbally approved by IDEM, took place from February 4 to 12, 2009, and proceeded in the following steps:

1) CAP18 ME® injection took place inside the Mexican store and the Laundromat (*Source Area A*), followed by outside in the Plaza parking lot (*Source Area B*), and west of Michigan Meadows Apartments Building No. 1 (*Source Area C*).

2) A total of 16,575 lbs of the product was successfully injected via 33 injection points.

3) The CAP18 ME® loadings proceeded as follows in each of the source areas:

    a) *Source Area A* (inside the Mexican store) - 3,000 lbs were injected via six injection points.
    b) *Source Area B* (Plaza parking lot) - 4,500 lbs were injected via nine (9) injection points.
    c) *Source Area C* (area north of Michigan Street, west of Apt Building 1) - 9,000 lbs were injected via 18 injection points

The injection logs indicating the distribution of product at each of the injection locations are attached in **Appendix F.**

The injection spacing for the selected design was determined by the expected radius of influence of the injections and the need for complete treatment of the groundwater as it

passes through the treatment zone. An injection spacing of 10 feet on centers was considered very effective for the sands encountered at the Site, with normal curtain 'rows' stacked two deep for each curtain area. Curtain areas were generally aligned along impacts or perpendicular to either the existing PCE plume or parallel with building walls that controlled injection accessibility. Injection points along each curtain row were spaced approximately 10 feet apart, with adjustments between rows to allow the most even distribution of vector lines downgradient from injection points. This configuration was designed to provide the most thorough coverage per *Source Area*. This design accounted for injecting the CAP18 ME® conservatively throughout the 'smear zone' and the entire saturated depth within the upper sand unit at each injection point.

Some field design adjustments to the injection distribution were made as the injection applications began in February 2009. These adjustments included:

- Introduction of the CAP18 ME® into the aquifer at 3-foot depth intervals.
- Injection of the CAP18 ME® throughout the sand and gravel aquifer down into the top of the underlying silty clay glacial till, which acts as a barrier to further vertical groundwater movement.
- Injection of a greater dose of CAP18 ME® into the upper 10 to 12 feet of the saturated zone as compared to greater depths. This placed the greatest mass of the product in the most impacted PCE zone of the aquifer. This also allowed for a longer period of activity from the presence of CAP18 ME® and its fatty acids in those areas, increasing their effectiveness. Thus, larger masses of CAP18 ME® injection loading were distributed in the more impacted zones of the aquifer in each *Source Area* plume to ensure the most longstanding availability of hydrogen for reductive de-chlorination. **Figure 26b** shows the final 2009 injection design layout.

*Sewer Sampling 2009*

Follow-up sewer line investigation was also performed on March 18, 2009 by collecting liquid samples from four different sewer locations running along Michigan Street (SS-P-01, SS-A-01, SS-A-02, and SS-A-03). The results provided in **Table 7** indicate that the indicator compounds concentrations reduced compared to previous levels.

*Indoor Air Monitoring 2009*

On February 26 and 27, 2009, indoor air samples (taken via summa canisters) were collected at four tenant units at Michigan Plaza (Village Pantry (3801), Vacant Handicapped space (3815), Mexican Grocery store (3819) and the Laundromat (3823)) with the air mitigation systems on, and at four apartments (Basement Apt. 101 (Building No. 1), Basement Apt. 602 (Building No. 6), Basement Apt. 1001 (Building No. 10), and Apt No. 109 (Second Floor, Building No. 1 (prior highest concentration)). Indoor air samples (via summa canisters) were also collected at Unit 3817) and Unit 3805 at Michigan Plaza on March 17, 2009.

Significantly reduced indoor air concentrations were identified (Apartment Building No. 1, Plaza 3815 space, Mexican store space) below or slightly above the IDEM new draft April 2006 target levels. Also, reduced concentrations were noted in the soil gas monitoring wells (MGW-01 and MGW-03) indicating COCs are being remediated in the area. One of the Apartment building basement apartments (Apt No. 1001) and one of the second floor apartments (Apt No. 108) also exhibited slight exceedances relative to IDEM action levels.

The indoor air results at the Village Pantry, Mexican store and the Laundromat were below both IDEM and U.S. EPA action levels (with the vapor mitigation systems running). Indoor air concentrations were observed to be noticeably reduced in the 3817 Michigan Street location (currently Alcoholics Anonymous) and the 3805 Michigan Street space (Old Library space, unoccupied). Please note that these spaces *did not* have vapor mitigation systems in place. This was a positive development demonstrating that site remedial activities had been successful in significantly reducing the indoor air impacts.

### 2.2.18 Regulatory Activities – Various Dates, 2009 - 2010

During 2009, several additional regulatory activities occurred. MUNDELL submitted a *Response to IDEM RWP Response to Comments and Addendum I Review* document dated January 16, 2009. The document was prepared in response to the IDEM letter dated November 17, 2008.

In 2009, the Marion County Public Health Department identified a neighborhood in the Holt Road area (west-southwest of the Site) where homes were using private drinking water wells; they were not connected to a municipal water system. Water samples collected from three residential wells contained VC at concentrations exceeding federal drinking water levels of 2 ug/L. In October 2009, IDEM formally requested assistance from the U.S. EPA to address the affected residential drinking water wells.

IDEM issued a letter to Genuine Parts and MUNDELL dated January 22, 2010 summarizing a meeting with the U.S. EPA. IDEM requested a well be installed west or southwest of MMW-P-03D, between Michigan Plaza and the residential wells.

Following a review of the Fourth Quarter 2010 CAPR, IDEM issued a letter dated March 30, 2011 discussing elevated vinyl chloride levels documented at the Site and requested vapor intrusion studies be completed for residences within 100 feet of the groundwater plume, including the residence to the immediate west.

Also during this timeframe, the U.S. EPA issued a *General Notice of Potential Liability* letter dated February 17, 2011, notifying AIMCO that it was potentially liable for the VC residential drinking water well impacts in the Holt Road area.

### 2.2.19 U.S. EPA - MUNDELL Groundwater Sampling Event – July 2010

As part of the U.S. EPA investigation of the Holt Road residences, the U.S. EPA START contractor (Weston Solutions Inc.; "Weston") completed a split groundwater sampling event with MUNDELL on July 7. 2010, sampling three monitoring wells: one MUNDELL monitoring well (MMW-P-01) and two Keramida/Environ monitoring wells (MW-165D and MW-170D). Weston also sampled six residential wells on their own (without split sampling), and completed a gauging event in October 2010 of 131 wells.

Groundwater samples were collected by U.S. EPA subcontractors and submitted for volatile fatty acid (VFA) analysis to determine if reductive dechlorination associated with the CAP18® injections was occurring. MUNDELL collected split groundwater samples at each of its monitoring well locations. Significant concentrations of VFAs are typically present in groundwater treated using enhanced bioremediation via injectable vegetable oils. Historical VFA analysis at the Site has shown elevated VFAs present in the groundwater, particularly immediately downgradient of the previous Source Area injection locations. Cumulative historical VFA analytical results at selected well locations are included in **Table 8**. The U.S. EPA split sampling event in July 2010 showed non-detect VFA concentrations in well locations upgradient (MW-165D) and cross gradient (MW-170D) of the Site, while VFA analysis from MMW-P-01, located in the heart of the Site, showed significantly elevated concentrations of all identified VFAs.

Weston prepared a report entitled Technical Memorandum dated March 27, 2011 that summarized their findings. MUNDELL included a discussion of these results in the April 27, 2011 *Technical Response to General Notice of Potential Liability* report. MUNDELL believed that the results of this VFA analytical testing and its observed distribution does not support the conclusion that there is a connection between the Site remedial activities and the observed elevated VC concentrations in the deeper saturated units supplying the residential wells to the west.

### 2.2.20 Geophysical Studies – Various Dates, 2011

Geophysical field activities in the vicinity of the Site were performed by MUNDELL on April 21, August 25, September 14 and 15, October 3 and 4, and November 8, 2011. The primary objective of these efforts was to support a detailed geologic and hydrogeologic interpretation of the surrounding area for the purpose of understanding of the thickness and distribution of the upper sand and gravel unit in the area and the areal extent (or continuity) and topographic expression of the base of this unit defined by an upper glacial till unit.

Six (6) two-dimensional resistivity profile lines (cross-sections) and four seismic refraction profiles were completed to aid in the detailed assessment and interpretation of the geologic variability in the vicinity of the Site. Specific focus was given to: determining the continuity of the upper till surface beneath the Site; the distribution of fine-grained glacial till sequences; the unconsolidated sand and gravel units; and the topographic

expression of the upper till surface. Also, thirteen (13) downhole natural gamma ray geophysical logs were completed of selected Site monitoring wells that were blind drilled in their deeper intervals to assist in defining aquifer composition and confirming proper screen placement within the aquifer.

A March 16, 2012 *Report of Geophysical Survey Investigation* was provided to IDEM within the March 16, 2012 *Additional Investigation Activities Summary Report* (see **Section 2.2.22**).

### 2.2.21 U.S. EPA and IDEM Response Activities - 2011

MUNDELL submitted a *Request for Revised Remediation Work Plan Approval* document dated April 21, 2011 to IDEM, and a *Technical Response to General Notice of Potential Liability* document dated May 9, 2011 to the U.S. EPA Region 5, with a copy also provided to IDEM. The *Technical Response* document was a response to the February 17, 2011 EPA letter. The *Technical Response* summarized previous investigations completed at the Site and provided the following conclusions:

1) The observed distribution of PCE/TCE/cis-1,2-DCE and VC in the vicinity of the Site indicates that the releases from the former Accent Cleaners had been fully adequately delineated prior to initiating on-Site remedial activities, and that the impacted groundwater area did not include areas west of Michigan Plaza.

2) Investigations of the release of chemicals from the sewer line in the area of the Site indicated the historic releases occurred at three locations north and east of the Plaza, and not west of the Plaza. Given the nature of the east-west sewer line (flow to the east), it is not a potential source for residences west of Holt Road.

3) All groundwater potentiometric maps and measurements, including those made by the U.S. EPA during 2010, indicate groundwater flow is to the south-southeast from the Site Source Areas. As such, releases from the Site area will flow coincident with groundwater movement, and not toward the residences west of Holt Road.

4) Remediation activities at the Site, while generating VC in the groundwater, did not cause groundwater flow directions to move to the west. The amount of vegetable oil injected was not of sufficient volume or applied at a sufficient rate to elevate groundwater levels in any short or long-term fashion that could cause movement of VC in the direction of the residences.

5) Mapped subsurface conditions in the area point to deeper aquifer units south of the Allison Plant 12 location that have not yet been assessed by Allison, either through geophysical surveys, confirmed with deeper drilling and characterization, or through sampling, as potential pathways and sources of impacts to the residences.

6) Based on all the data gathered to date, the most likely historical chemical source areas causing the observed VC impacts at the residence wells are located upgradient either to the north/northwest or north/northeast.

IDEM responded to the *Request for Revised Remediation Work Plan Approval* document and *Technical Response to General Notice of Potential Liability* document in a June 22, 2011 letter. Regarding the *Technical Response to General Notice of Potential Liability* document, IDEM indicated that the Michigan Plaza source areas and groundwater plume were not fully defined, and IDEM did not concur that deep contamination across the site is wholly the responsibility of Genuine Parts, or that Michigan Plaza cannot be the source of VC contamination in the residential drinking water wells. Also, IDEM raised concerns of blind-drilled wells across the Site, suggesting that more completely logged wells would be needed for remediation and closure purposes.

Regarding the *Request for Revised Work Plan Approval* document, IDEM responded indicating proposed monitoring well locations were acceptable, that IDEM was not opposed to additional CAP18® injections, with a caveat that water level measurements and sampling prior to and following injections be completed. The IDEM letter emphasized the need to cooperate with U.S. EPA regarding identifying the source of the vinyl chloride in the residential wells and to conduct methane monitoring given the CAP18® injections that have occurred.

### 2.2.22 Additional MUNDELL FSI Activities - Aug - Dec 2011

In response to requests from IDEM, MUNDELL conducted additional investigation activities between August and December 2011. IDEM requested additional delineation activities along the sewer line running north-south along the western side of the Plaza building, in the deep saturated zone near *Source Area A* west/southwest of Michigan Plaza towards Holt Road, and south of Cossell Road in the Floral Park Cemetery. IDEM also expressed interest in developing a better understanding of the underlying glacial till surface beneath the upper sand and gravel unit.

Six (6) soil borings (MMW-P-11D, MMW-P-11S, MMW-P-12D, MMW-P-12S, MMW-P-13D, MMW-P-13S) were advanced on August 31 and September 1, 2011, in preparation for the installation of three pairs of nested monitoring wells. Each soil boring location was completed using a truck-mounted direct-push Geoprobe unit. Soil was continuously logged for each boring location and field screened using a PID. Unsaturated soil samples were collected from intervals immediately above the water table in the vadose zone and from the basal till unit underlying the saturated sand and gravel unit across the Site. Groundwater samples were collected in approximately ten-foot intervals from each deep soil boring location to characterize and vertically delineate the groundwater quality within the saturated zone.

Following soil description via the Unified Soil Classification System (USCS) and PID screening activities, selected sample intervals were prepared for laboratory submittal via

U.S. EPA SW-846 Method 5035A. Soil samples were submitted for volatile organic compound (VOC) analysis via U.S. EPA SW-846 Method 8260 and for total organic carbon (TOC) analysis via the Walkley-Black method. After continuous logging was completed for the deep soil boring locations, discrete groundwater sampling intervals were selected based upon the saturated zone thickness encountered at each location. A screened point sampler was driven to the selected depth interval to obtain groundwater samples that were subsequently submitted for VOC analysis via U.S. EPA SW-846 Method 8260.

Six monitoring wells (three nested well sets) were installed in the previously described soil boring locations. The deep monitoring wells, (MMW-P-11D, MMW-P-12D and MMW-P-13D), were installed at the base of the saturated sand and gravel unit allowing for continued monitoring of the deep saturated zone. The shallow monitoring wells, MMW-P-11S, MMW-P-12S and MMW-P-13S, were installed adjacent to their respective deep wells and MUNDELL utilized a ten-foot screen located within the appropriate depth interval to evaluate ongoing conditions in the upper saturated zone of the sand and gravel unit.

It should be noted that during the installation of MMW-P-11D, a private forced sewer line was encountered approximately three (3) ft-bgs. Because the sewer line was associated with a private lift station which does not continuously operate, the breached line was not immediately apparent. Following the confirmation of the private sewer line location via as-built drawings provided by the City of Indianapolis, MMW-P-11D was promptly abandoned by an Indiana Licensed well driller according to Indiana Administrative Code requirements. MMW-P-11D was replaced with MMW-P-11DR during the second round of soil and groundwater investigation activities which took place during December 2011. The sewer was subsequently repaired as well.

As part of MUNDELL's additional investigation activities conducted at the Site in September 2011, two stream gauge staffs were installed in the streambed of Little Eagle Creek. SG-1 was placed immediately north of the Michigan Apartments and south of the Genuine Parts facility, and SG-2 was placed immediately south of the Michigan Street bridge located east of the Site. Both stream gauges were surveyed into the existing monitoring well network for inclusion in all future groundwater elevation gauging events.

From December 5 through December 15, 2011, nineteen (19) soil borings (GP-20, GP-21, GP-22, GP-23, GP-24, GP-25, GP-26, GP-27, GP-28, GP-29, GP-30, GP-31, MMW-P-11DR, MMW-P-14S, MMW-P-14D, MMW-15S, MMW-15D and MMW-C-02D) were completed to further delineate soil and groundwater conditions to the south and west of the Plaza property and along the western edge of the Apartments, immediately east of Holt Road. Six (6) of the boring locations were completed in preparation for installation of monitoring wells. Included in the monitoring well installation activities was MMW-P-11DR, the replacement monitoring well for MMW-P-11D (previously abandoned due to a broken sewer line in the vicinity). As such, no soil or groundwater samples were collected from MMW-P-11DR during drilling.

Soil and grab groundwater sampling was conducted as previously conducted in August-September 2011. It should be noted that due to the unconsolidated sand and gravel lithology present beneath the Site, significant sand heaving issues were encountered during drilling activities. In cases where refusal was encountered (GP-24, GP-25, GP-26, GP-27, GP-28 and GP-29), a screened point sampler was advanced into the deeper saturated zone for groundwater sample collection. Due to the sand heave and resulting Geoprobe refusal, basal clay till soil samples could not be collected from these locations.

Six monitoring wells (two nested sets, one (1) deep monitoring well, and one (1) replacement monitoring well) were installed in the previously identified soil boring locations (MMW-P-11DR, MMW-P-14S/D, MMW-15S/D and MMW-C-02D).

*Results*

Soil VOC analytical results were below the method detection limits for all submitted soil samples with the exception of PCE in the shallow MMW-P-12D sample (16.0-18.0'), and cis-1,2-DCE in the deep MMW-P-12D sample (36.0-37.0'), which was located below the water table. The PCE concentration of 51.3 mg/kg in the MMW-P-12D (16.0-18.0') sample exceeded the IDEM RISC 2009 IDCL and is above the 2012 RCG C/I Direct Contact Level. Cis-1,2-DCE concentrations in MMW-P-12D (36.0-37.0') were below all IDEM RISC 2009 DCLs for soil.

It should be noted that during previous soil investigations at the Site, PCE concentrations present in shallow soil intervals were of the same order of magnitude as those seen in the MMW-P-12D (16.0-18.0' interval). Although the PCE concentration in soil here was elevated, no PCE impacts were observed in either of the groundwater samples collected from the MMW-P-12S and MMW-P-12D boring locations.

Groundwater VOC analytical results were below method detection limits in all six (6) locations for PCE, TCE and trans-1,2-DCE. Cis-1,2-DCE was detected above the IDEM RISC 2009 RDCLs in both shallow and deep groundwater samples collected from MMW-P-12D. VC was detected in Geoprobe soil boring groundwater samples (MMW-P-11D, MMW-P-12D and MMW-P-13D) with concentrations exceeding the IDEM RISC 2009 IDCLs. The relative concentrations in each monitoring location were consistent with previous investigation, delineation and monitoring activities at the Site, which indicated deeper VC impacts were likely in those areas due to migration from the upgradient Genuine Site sources to the north. It was anticipated that ongoing remedial activities (supplemented reductive de-chlorination via CAP18 ME® injections) would continue to address any remaining groundwater impacts generated and present at the Site.

While elevated VC concentrations were explained by enhanced reductive de-chlorination processes ongoing near the previous injection locations, monitoring well nest MMW-P-13S/D is located over 200 feet west/southwest and cross-gradient from

*Source Areas A* and *B*. Notably, PCE or cis-1,2-DCE concentrations were not detected in either MMW-P-13S or MMW-P-13D. In addition, VC concentrations in MMW-P-13D were higher than both MMW-P-11D and MMW-P-12D which are closer to *Source Areas A* and *B*.

During the December 2011 investigation at the Site, soil and groundwater samples were analyzed for VOCs in fifteen (15) selected deep soil boring locations advanced at the Site (GP-20, GP-21, GP-22, GP-23, GP-24, GP-25, GP-26, GP-27, GP-28, GP-29, GP-30, GP-31, MMW-P-14D, MMW-15D and MMW-C-02D). Soil VOC analytical results were below the method detection limits for all submitted soil boring samples with the exception of PCE in the shallow GP-31 sample (16.0-17.5') and VC in the deep GP-30 sample (35.0-35.5'), likely a reflection of groundwater quality at that depth. The PCE concentration of 68.5 ug/kg in the shallow GP-31 sample exceeded the IDEM RISC 2009 RDCLs but was below the IDCLs. The VC concentrations in the deep sample interval for GP-30 (26.8 ug/kg) exceeded the IDEM RISC 2009 RDCLs for soil but is below the IDCLs.

GP-30 and GP-31 were located adjacent to the north-south running sewer line along the western side of the Plaza building. Previously, no soil or groundwater investigations had been conducted along this section of sewer line due to the presence of overhead power lines adjacent to the Plaza building. These overhead power lines were relocated from the western side of the Plaza building in late 2011, allowing further soil and groundwater investigation activities to occur in that area.

The concentration of PCE detected in the GP-31 shallow soil sample (e.g. 68.5 ug/kg at 16.0-17.5') was one to two orders of magnitude lower than those seen in previous investigations in Source Areas at the Site, and is close to the IDEM Residential Default Closure Level (RDCL). The low level of PCE at GP-31 and the lack of detection at GP-30 indicated that, historically, PCE was likely released in the vicinity of or just north of GP-31 and that the previously inferred *Source Area A* extended to the west to include a portion of the north-south running sewer line. Groundwater analytical results obtained from MMW-P-11S (where PCE was detected in shallow groundwater at 76.1 ug/L) downgradient of the north-south leg, i.e., GP-31, during the September 2011 baseline sampling event also supported this conclusion.

Groundwater VOC analytical results indicated the presence of VC and cis-1,2-DCE in GP-30, and PCE, TCE, cis-1,2-DCE and VC in GP-31 along the western edge of Plaza building. Neither PCE nor TCE was detected in the shallow groundwater sample collected from GP-30 (25.0'). Both PCE and TCE were detected above IDEM RISC 2009 RDCLs in the shallow groundwater sample collected from GP-31 (26.0'). Cis-1,2-DCE was detected in the shallow groundwater samples collected from both GP-30 and GP-31; however, these cis-1,2-DCE concentrations remained below all IDEM RISC 2009 IDCLs. In addition, VC was detected above the IDEM RISC 2009 IDCL in shallow groundwater samples collected from GP-30 and GP-31. Detections of cis-1,2-DCE and VC in the shallow groundwater at the GP-30 and GP-31 locations were anticipated as a likely result

of ongoing reductive dechlorination processes from the Site. Both of these areas are downgradient of ***Source Area B***.

The deep groundwater samples from GP-30 and GP-31 had no detectable PCE or TCE. In both samples, cis-1,2-DCE was detected below all IDEM RISC 2009 RDCLs and VC was detected above IDEM RISC 2009 IDCLs.

Cis-1,2-DCE and VC had been present consistently within the deep saturated unit underlying the Site dating back to 2002. Both GP-30 and GP-31, along with monitoring well MMW-15D (downgradient of the Genuine Site and upgradient of Michigan Meadows Apartments and Michigan Plaza), exhibited detectable groundwater concentrations of cis-1,2-DCE below IDEM RDCLs. VC was present in the deep groundwater samples collected from GP-30, GP-31 and MMW-P-14D (located along the western edge of the Floral Park Cemetery property immediately east of Holt Road and just north of Cossell Road) above the IDEM IDCL.

The remaining cis-1,2-DCE concentrations within the deep saturated zone were likely attributable to the upgradient Genuine Site source to the north of Michigan Plaza and Michigan Meadows Apartments *Source Areas* since they now reflected background concentrations coming from the north. The continuing deep groundwater VC concentrations, however, were the result of both the Genuine Site impacts and the remediation reductive de-chlorination VC generation effects. These VC levels were continuing to decline more rapidly than the upgradient VC source, according to the injection design (see remediation concentration trend summaries for cis-1,2-DCE and VC at the Michigan Plaza in Figure 4 of the MUNDELL 4Q11 QMR).

All of the soil samples collected from the Floral Park Cemetery property soil borings were below detection limits for VOCs. Limited VC groundwater concentrations exceeding the IDEM RISC 2009 IDCLs were observed along the northern edge of the Cemetery property (GP-21 - 28.0', 4.9 ug/L; GP-21 - 38.0', 2.8 ug/L; GP-23 - 37.0', 7.2 ug/L; GP-24 - 28.0', 2.9 ug/L; and GP-24 - 38.0', 4.8 ug/L). No VOCs were detected in the remaining seven (7) cemetery boring locations (GP-20, GP-22, GP-25, GP-26, GP-27, GP-28 and GP-29). These soil and groundwater analytical results indicated that the leading edge of the deep VC plume had been successfully delineated, extending in a downgradient (south-southeast) direction no further than 200 feet onto the Cemetery property south of Cossell Road.

The results from the investigation, including the geophysical survey, were discussed in detail in the *Additional Investigation Activities Summary Report* submitted to IDEM on March 16, 2012.

### 2.2.23 U.S. EPA Vermont Street VC Investigation, Nov - Dec 2011

Between November 9 and 18, 2011, the U.S. EPA conducted subsurface drilling activities to collect analytical and hydrogeologic data in areas between the residential neighborhood (the "Vermont Street Site") and Allison, Genuine Parts, and Michigan

Plaza. Six (6) direct push borings (SB-01 through SB-06) were advanced along the north side of West Michigan Street, east of Holt Road, and in the Residential Area. The U.S. EPA collected twelve (12) soil samples from the six direct push soil borings and submitted them to Pace for VOC analysis. U.S. EPA installed five (5) vertical aquifer sampling (VAS) borings (VAS-01 through VAS-05) were advanced in the study area utilizing RotoSonic drilling methods, followed by placement of temporary well screens to collect groundwater samples. Samples from each VAS boring were collected at approximately ten-foot intervals to a maximum depth of sixty-eight (68) feet bgs at VAS-05. In all, fifteen (15) groundwater samples were collected from the VAS locations and submitted to Pace for VOC analysis.

Following collection of grab water samples, permanent monitoring well nests were installed at each location. Two monitoring well-nests were installed at VAS-03 (MW-WES-03a, MW-WES-03b) and VAS-04 (MW-WES-04a, MW-WES-04b), while three monitoring well-nests were installed at VAS-01 (MW-WES-01a, MW-WES-01b, MW-WES-01c), VAS-02 (MW-WES-02a, MW-WES-02b, MW-WES-02c), and VAS-05 (MW-WES-05a, MW-WES-05b, MW-WES-05c) for a total of thirteen (13) wells.

Between December 6 and 9, 2011, a unified groundwater elevation gauging event was conducted which included 152 wells in concert with the collection of sixty-six (66) groundwater samples from the area-wide monitoring well network including monitoring wells from MUNDELL, ARCADIS, ENVIRON, and the new U.S. EPA locations. Low-flow sampling technology was utilized by the U.S. EPA to obtain groundwater samples from all monitoring well locations.

In addition, in January 2012, the U.S. EPA completed an area-wide elevation and location survey event to obtain ground surface and top-of-casing elevations, as well as latitude and longitude coordinate data for each monitoring well location included in the December 2011/January 2012 groundwater sampling and gauging event.

*Soil Boring Results*

Sample results from the direct push soil borings were non-detect with exception of SB-05, advanced along the sewer line north of the Michigan Plaza property (*Source Area B*). PCE was detected at concentrations of 0.148 mg/kg (14-15 ft-bgs) and 9.19 mg/kg (17-18 ft-bgs), respectively.

Based on a review of VAS results, both cis-1,2-DCE and VC were detected in groundwater samples. Cis-1,2 DCE was detected in VAS-02 (25-30') at a concentration of 6.7 ug/L. VC concentrations were limited to the deeper saturated units:

- VAS-01 (32.5-37.5'): 60.1 ug/L;
- VAS-01 (41.0-46.0'): 40.9 ug/L;
- VAS-01 (50.0-55.0'): 32.4 ug/L;
- VAS-02 (35.0-40.0'): 23.0 ug/L;

- VAS-02 (45.0-50.0'): 5.5 ug/L); and
- VAS-03 (30.0-35.0'): 6.3 ug/L).

*Permanent Monitoring Well Results*

Cis-1,2-DCE was detected (11.4 ug/L) in shallow well MW-WES-02a. VC was detected (at concentrations ranging between 2.1 and 65.2 ug/L) in MW-WES-01a, MW-WES-01b, MW-WES-01c, MW-WES-02b, and MW-WES-02c. U.S. EPA analytical results from the investigation are summarized in **Table 1** (soil) and **Table 7** (grab water).

The findings, including the above-mentioned tables, were presented in a *Technical Memorandum – Analytical and Hydrogeological Evaluation* report dated January 30, 2013 prepared by Weston Solutions Inc. of Okemos, Michigan (EPA START contractor).

### 2.2.24 MUNDELL Floral Park Cemetery Well Installation - June 2012

Between June 4 and 6, 2012, MUNDELL oversaw the installation of monitoring wells MMW-C-16S, MMW-C-16D, and MMW-C-17D at two (2) locations in Floral Park Cemetery south of Michigan Plaza. The scope of work was previously summarized in the *Response to IDEM's Request for Revised Remediation Work Plan Approval Review and Technical Response to General Notice of Potential Liability Review* document dated March 16, 2012. A work plan was provided to IDEM prior to the initiation of activities. The purpose of the monitoring well installation was to further delineate PCE downgradient of *Source Area A* along the eastern edge of the Floral Park Cemetery (MMW-C-16S and MMW-C-16D) and vinyl chloride southeast of MMW-P-09D in the vicinity of historic soil boring GP-23 (MMW-C-17D).

Soil samples were collected continuously from each deep boring and the samples were classified by a MUNDELL scientist. Soil samples were collected and submitted for analysis. Following completion of the soil borings, permanent wells were installed and were subsequently incorporated into the quarterly groundwater monitoring program. Based on soil analytical results, adsorbed vinyl chloride was reported in excess of the associated IDEM 2012 RCG migration to groundwater screening levels at monitoring well MMW-C-16D.

### 2.2.25 MUNDELL Soil Borings - March 2013

Between March 5 and 11, 2013, MUNDELL oversaw the advancement of fifteen (15) soil borings across the Site. Nine (9) borings (MMW-08S-A, MMW-09S-A, MMW-10S-A, MMW-11D-A, MMW-13D-A, MMW-14D-A, SB-100, SB-101, and SB-102) were advanced at the Maple Creek Village Apartments complex. Five (5) borings (MMW-P-02-A, MMW-P-03D-A, MMW-P-04-A, MMW-P-07-A, and MMW-P10D-A) were advanced at Michigan Plaza, One boring (SB-103) was advanced within the right-of-way west of Michigan Plaza *Source Area B* along the south side of Michigan Street. The soil borings were advanced to verify lithology at previously blind-drilled zones of existing

monitoring wells, and to collect additional soil data in the vicinity of the *Source Areas*. Soil borings were sampled either continuously across previously blind-drilled intervals, or in the case of new boring locations, sampling was continuous to the terminus depth.

Based on soil analytical results, adsorbed PCE in excess of the associated IDEM 2012 RCG Direct Contact Commercial/Industrial level was identified in MMW-P-02-A and SB-101, and in excess of the 2012 RCG MTG level in MMW-10S-A and MMW-P-04-A. Adsorbed TCE in excess of the associated IDEM 2012 RCG MTG level was identified in MMW-P-02-A and SB-101. Adsorbed cis 1,2-DCE in excess of the associated IDEM 2012 RCG MTG level was identified in MMW-09S-A, MMW-14D-A, MMW-P-02-A, MMW-P-07-A, and SB-103. Adsorbed VC in excess of the associated IDEM 2012 RCG MTG level was identified in MMW-09S-A, MMW-10S-A; MMW-13D-A, MMW-14D-A, MMW-P-07-A, MMW-P-10D-A, SB-100, SB-101, and SB-103.

To minimize clutter on the map, the "–A" suffix boring offsets to pre-existing monitoring wells are not labeled or depicted; they were located approximately 3 to 4 feet from the associated well.

The results of these investigations were summarized in the MUNDELL *First Quarter 2013 QMR* dated April 30, 2013. During this timeframe, Minning/MUNDELL also submitted a *Technical Response* dated April 18, 2013 that was a response to the Weston/U.S. EPA January 2013 *Technical Memorandum* document (see **Section 2.2.21**).

### 2.2.26 MUNDELL Soil Borings - July 2013

On July 19, 2013, during the 3rd round of CAP18 M® injections, MUNDELL oversaw the advancement of two (2) soil borings. MMW-P-08A was advanced at Michigan Plaza, and MMW-P-09D-A was advanced within the right-of-way northwest of the intersection of Cossell Road and Olin Avenue. The soil borings were advanced to verify lithology at previously blind-drilled zones of existing monitoring wells. Soil borings were sampled continuously across previously blind-drilled intervals. Samples were not submitted for analysis.

## 2.3 Techniques Utilized during Historic Investigations

The following sections will provide a summary of the techniques utilized during the historical investigations to date, with a focus on the investigations completed by MUNDELL. A summary of the investigations completed by others can be found within the reports listed within the reference section (see **Section 4.0**).

### 2.3.1 Soil Sampling

MUNDELL's soil sampling at the Site has followed MUNDELL's Standard Operating Procedures for soil sampling, provided in **Appendix G**. Soil samples have been

collected utilizing U.S. EPA SW-846 collection Method 5035. Soils have been identified utilizing American Standard Testing Method D-2488: Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

### 2.3.2 Groundwater Sampling

MUNDELL's groundwater sampling at the Site has followed MUNDELL's Standard Operating Procedures for groundwater sampling, provided in **Appendix G**. Groundwater had originally been collected with disposable polyethylene bailers; in recent years, a micro-purge low flow sampling system has been used to collect groundwater samples from all wells whenever possible. Dedicated pumps are also present in several wells across the Site.

### 2.3.3 Air Sampling

MUNDELL's air sampling at the Site has followed MUNDELL's Standard Operating Procedures for air sampling, provided in **Appendix G**. Air sampling has historically consisted of sub-slab air samples, quarterly air samples collected from the seven (7) soil vapor extraction systems that have been installed, and the annual collection of indoor air samples from select tenant spaces along with outdoor ambient air and soil gas samples.

Indoor air samples have been analyzed by a gas chromatograph/mass spectrometer (GC/MS) for PCE, TCE, cis-1,2-DCE, and VC utilizing a modified U.S. EPA Method T0-15 for Single Ion Monitoring (SIM). SIM allows detection of very low (sub-part per billion) concentrations of indicator analytes.

### 2.3.4 Monitoring Well Installation

Monitoring wells were installed either using Geoprobe™ drill units or drilling rigs equipped with hollow-stem augers to advance borings into the unconsolidated deposits beneath the Site and surrounding areas. Each monitoring well installed was constructed of two-inch diameter, flush-joint, threaded Schedule 40 Polyvinyl chloride (PVC) riser with either a five or 10-foot long, 0.010 inch machine-slotted PVC screen. The only exception is well MMW-13D, which was constructed with a 15-foot long screen. A filter pack consisting of No. 4 sand was installed around the bottom of each screen to a height of approximately one to two feet above the top of the screen. Bentonite chips were placed into the annular space around the riser and hydrated to create a seal to near the ground surface. The monitoring wells were finished with a flush-mounted, bolt-down steel manhole cover set in place with a concrete pad to provide protection and stability to the wells. The wells were then fitted with a watertight well cap to prevent the infiltration of surface water.

After each well was completed, the top of each well riser was surveyed into the existing Site monitoring well network (For wells installed prior to 2012, Top of Casing data was

obtained from or referenced to the Unified U.S. EPA Elevation Survey completed on October 13, 2011). Finally, the monitoring wells were developed to assure the well was in good hydraulic communication with the surrounding subsurface materials. The monitoring well construction logs are contained within **Appendix E**. The monitoring well network top of casing elevations are provided within **Table 1**. An illustration of the location of the historical soil boring and monitoring wells is provided in **Figure 2a**.

### 2.3.5 Geophysical Surveys

MUNDELL completed geophysical surveys at different times for the investigation and characterization of the Michigan Plaza and Maple Creek Village Apartments, including: deep metal electromagnetic, terrain conductivity, 2-D resistivity, refraction seismic, ground penetrating radar (GPR) and downhole logging following MUNDELL's Standard Operating Procedures for geophysical surveying provided in **Appendix G**.

## 2.4 Summary of Site Investigation Results

### 2.4.1 Site Chemicals of Concern

Throughout the investigation studies and monitoring events that have been conducted, detectable levels of eleven (11) VOCs (PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, VC, chloroform, methylene chloride, naphthalene, toluene, acetone, and 1,2,3-trichlorobenzene) have been observed in the soil or groundwater. Three compounds have been detected on several occurrences (methylene chloride, toluene and acetone) which are believed to have been laboratory artifacts and not representative of actual groundwater conditions at the Site.

Of the VOC compounds detected, only PCE, TCE, cis-1,2-DCE and VC were present above both 2009 RISC IDCLs and RDCLs, and above the more recently instituted 2012 IDEM RCG C/I and Residential Screening Levels for soil, groundwater, and indoor air. Many of the soil samples, however, were obtained at or below the water table, i.e., at depths of greater than ten (10) to twenty (20) ft, and are most likely indicative of groundwater impacts than soil impacts. Historical summaries of COC concentrations provided in **Table 2** for soil, **Table 3** for groundwater (from monitoring wells), **Table 4a and 4b** for indoor air, **Table 4c** for soil gas, **Table 5** for mitigation system air results, **Table 6** for surface water, and **Table 7** for grab water samples (from soil borings) and sewer samples. It should be noted that active in-situ bioremediation was initiated in August 2007 which began the process of sequential chemical de-chlorination (see **Section 2.2.17** for greater description) and, as such, chemical concentrations after that point in time within and downgradient of the treated areas reflect the efforts to reduce chemical concentrations through this process. The resulting transient chemical trends in some cases significantly decrease the observed concentrations (*e.g.*, PCE) while temporarily increasing others (*e.g.*, cis-1,2-DCE and VC) prior to full remediation.

### 2.4.2 Site Chemicals of Concern Toxicological Data

For the compounds listed within Section 2.5.1, a ToxFAQ from the Agency of Toxic Substance & Disease Registry (ATSDR), is contained within **Appendix H** for each compound detected above the Site cleanup goals.

### 2.4.3 Sources of Contamination

Chemical source areas for the Genuine site are summarized in the Keramida Environmental March 29, 2002 *Phase II Investigation Report* (Keramida Figures 19a, 19b, 20a, 20b, 21a, 22a and 22b) and the Keramida August 16, 2004 Remediation Work Plan (Keramida Figures 14c, 14d and 20). Based on the data in these reports confirming the presence of this upgradient source, dissolved TCE, cis-1,2-DCE and VC from the Genuine site have been identified in an area including and extending to some degree south of both the Maple Creek Village Apartments and Michigan Plaza at concentrations above IDEM RISC IDCLs and RDCLs. Discussion of these indicator compounds contributing to background conditions is provided in **Section 2.6.**

Delineation of shallow PCE chemical source areas directly related to the Michigan Plaza/Maple Creek Village Apartments Site has been summarized in previous MUNDELL reports. Additionally, the sewer line liquid sampling, camera investigation, and soil sampling in the sewer tie-in activities all confirm the distribution as reported. The primary source of contamination was associated with the sewer line that extends from the 3819 tenant space to the west side of the Michigan Plaza, running north along the west side of the Plaza to the northern property line, turning east then north across Michigan Street, and then extending to the east toward a lift station near Little Eagle Creek. A leg of the sewer line that extends north into the apartment complex near Building No. 1 also represents an apparent historic pathway (of limited extent) for contamination from the main sewer run. The three source areas identified during the Site characterization process (see **Figure 2a**) are as follows:

- ***Source Area A*** - beneath the Michigan Plaza building, with the plume centering longitudinally and originating in the former location of Accent Cleaners (currently Iglesia Arca de Salvacion- Unit 3819), extending north along the western side for approximately 75 ft and extending off site south-southeast of the Plaza building into the Floral Park Cemetery property;

- ***Source Area B -*** north of Michigan Street south of Buildings Nos. 6 and 10 at the Maple Creek Village Apartments from the leaking sewer line, extending onto the northwestern corner of the Michigan Plaza; and

- ***Source Area C -*** from the sewer connector located west of Building No. 1 to the building, extending south to the east-west sewer line north of Michigan Street, and east to the vicinity of monitoring well MMW-10S.

A conceptual site model sketch indicating the Site setting, the chemical source areas and release mechanisms is provided as **Figure 27.** An associated conceptual site model diagram for risk evaluation is provided as **Figure 28.**

### 2.4.4 Groundwater Plume Characteristics

The direction of groundwater flow on Site is to the south-southeast. As discussed in *Section 2.4.3*, contaminant plumes on Site originate at three ***Source Areas*****.** Based on slug testing of seven wells (MMW-P-02, MMW-11S, MMW-11DR, MMW-P-13S, MMW-P-13D, MMW-P-14S and MMW-P-14D) in March and April 2013, the hydraulic conductivity of the upper sand and gravel aquifer on the Site ranged from 117.0 to 27.5 ft/day, with a median value of 70.9 ft/day and a mean value of 70.1 ft/day (R.C Minning and MUNDELL, 2013).

A historical cumulative cVOC indicator trend plot for the Site is provided as **Figure 29**, and a parent daughter trend plot is provided as **Figure 30**. Based on a review of the most recent data from the monitoring wells associated with the Site, the chlorinated solvent plumes appear to follow a degradation pathway where PCE and TCE are most pronounced in the vicinity of the three identified source areas, with PCE exhibiting higher concentrations and a larger plume. In most areas, PCE concentrations have decreased substantially since prior to the first round of injections in August 2007. However, PCE degradation appears to have declined recently at MMW-1S, MMW-8S, MMW-9S, MW-168S, MMW-C-01, MMW-P-01, and MMW-P-11S. The same is true of TCE in MMW-1S, MMW-3S, MMW-9S, MMW-10S, MMW-P-01, and MW-168S. PCE and TCE are not detected in the deep wells. Note that the most recent data is from the second quarter 2013, which was collected prior to the third round of CAP18$^{TM}$ injections.

The zone of chlorinated solvent affected groundwater continues to degrade to cis-1,2-DCE and VC in the direction of groundwater flow. The shallow plumes for these compounds are larger than the PCE and TCE plumes because the previous 2007 and 2009 CAP 18 ME $^{®}$ injection events have facilitated the generation of the chlorinated solvent daughter products (cis-1,2-DCE and VC) through sequential dechlorination.

With respect to VC, the shallow plume exhibits its highest concentrations between *Source Areas A* and *B,* having resulted from the generation and migration of VC from the breakdown of significant shallow PCE concentrations that has occurred in *Source Area B* (see **Figure 31h**). Shallow VC concentrations of lesser magnitude are also currently evident in areas south-southeast of *Source Areas B* and *C*. The deep VC plume attributed to the bioremediation at the Plaza is more heavily concentrated immediately downgradient of *Source Area B,* and to a lesser extent downgradient of *Source Area C,* where it continues to migrate in a south-southeast direction with groundwater flow (see **Figure 31l**).

It should be noted that, much like the cis-1,2-DCE plume, there is a significant component of VC in the deep portion of the upper aquifer that originates from the

Genuine Parts site to the north and moves through the Apartments and Michigan Plaza properties (*e.g.*, see **Figure 31g and 31h)** near the northern Apartments property line). This deeper VC plume is much more widespread across the area. The actual extent of the contribution of the Michigan Plaza bioremediation efforts to deeper VC impacts is apparent in comparing the extent of the shallow VC impacts (**Figure 31h**) with the deep VC impacts (**Figure 31l)**. It is expected that the deeper VC impacts related to the Michigan Plaza bioremediation efforts are mirrored by the extent of the shallow VC impacts, which are limited, more or less, to the identified Source Areas and downgradient areas from those locations.

**Figures 31a to 31l** depict both baseline/pre-injection groundwater cVOC concentrations and the most recent post-injection concentration trends.

MUNDELL has previously explained based on various technical details discussed in previous documents, that the VC affecting properties to the west cannot be attributed to the Plaza-Apartments Site. However, in a June 3, 2013 IDEM letter associated with the work plan review for the Third Round of CAP18 ME™ injections, IDEM requested that the forthcoming RWP include contingency plans for ensuring that these drinking water wells are protected. To that end, a contingency discussion is provided in **Section 3.6.9**.

### 2.4.5 Groundwater Elevation Monitoring During Injections

Based upon the measured mean hydraulic conductivity value of 70 ft/day, MUNDELL evaluated the expected behavior of groundwater during a typical 10-hour CAP 18® injection in which the maximum discharge (injection) rate would be limited to about 3 gpm. Note that the actual injection rates for the 2007 and 2009 injection events ranged between 0.38 and 0.70 gpm (see **Appendix F**, **Table F1**). As set forth in the *Response to IDEMs Review of Second Revised Work Plan For the Third Round of CAP18ME™ Injections* document dated April 29, 2013 and included in **Appendix I**, our analysis used the pump/injection test software AQTESOLV™ to simulate a constant pumping rate of 3 gpm into a 20 ft thick saturated aquifer with a K value of 70 feet/day, and a storativity (specific yield, S) range of 0.1 to 0.3. The analysis showed that the theoretical maximum response (in this context, water level rise) in the groundwater level at a distance of 1 foot from the injection point was estimated to range between 0.27 and 0.31 ft, with the rise in groundwater level at a distance of 10 feet away from the injection point to be between 0.12 and 0.16 ft. Mounding effects were predicted to be negligible (say 0.02 ft or less) at a 50-foot distance from the injection point. Therefore, mounding effects even within close proximity to the injection point are expected to be minimal. In addition, once injection stops, the AQTESOLV™ analysis predicted that it would take two hours or less for the groundwater levels to return to approximate pre-injection conditions. This theoretical analysis fully supports the conclusion that no significant mounding of groundwater would occur during the CAP 18® injections.

As requested by IDEM, MUNDELL conducted water level and CAP 18® measurements at selected locations in connection with the 3rd CAP 18ME™ injection event. The following wells were monitored before, during and after the injection:

MMW-01S, MMW-09S, MMW-10S, MMW-P-01, MMW-P-02, MMW-P-07, MMW-P-11S/D, MMW-P-12S/D, MMW-P-13S/D, MMW-P-14S/D, and MW170S/D.

Groundwater level measurements were made with transducers in the monitoring wells listed above at a frequency of one reading per minute. Water level measurements were also taken in monitor wells at greater distances with water level indicators at a rate of approximately once per hour. Water level measurements were taken before, during and after the injections were completed to verify that either 'no rise' in groundwater level had been observed, or the water level returned to pre-injection conditions. Monitoring wells utilized for water level measurements were probed with an oil/water interface indicator to determine the presence/absence of any CAP18 ME™.

To provide additional longer-term water level data following the injection event, transducers were left in MMW-P-11S/D, MMW-P-13S/D, and MMW-P-14S/D to observe long-term water level fluctuations during the quarter following injections. Periodic measurements will be made in these wells with an oil/water interface probe to monitor for the presence/absence of CAP 18®.

*Transducer Placement*

Transducers were placed in the referenced wells and activated on July 1, 2013, one week prior to injection activities. Time series plots for wells in the vicinity of a particular source area were prepared, along with plots of precipitation data based on USGS Gauging Station 3353600 (Little Eagle Creek at Speedway, Indiana), approximately one mile upstream, near the Indianapolis Motor Speedway.

All transducers performed as designed, except for the transducer installed in MMW-01S, which failed shortly after monitoring began on July 1 2013. After the faulty transducer had been identified, a replacement transducer was positioned in the well, but several days of monitoring were inadvertently missed as a result of the failed equipment. Despite this, a reasonable data set of gauging coverage was derived in order to draw conclusions on the hydraulic regime during the injection event.

*Precipitation Overview*

During the week leading up to the injections, the area received approximately one inch of precipitation. A roughly 2.5 foot stream displacement was observed at the upstream USGS gauging station early in the morning of July 3. Smaller precipitation events occurred later in the injection activities, but not to the degree seen in the week prior to starting injections.

*Gauging Results*

A review of the gauging data indicates that a noticeable short-term rise in water levels occurred across the study area coincident with the July 3rd, 2013 rise in Little Eagle and Eagle Creek, followed by a gradual drop in water levels over the two-week injection period. The possible explanations to explain the initial rise in water levels would either involve precipitation recharge from non-paved areas, and/or the hydraulic influence from the creeks. Reviewing the time series plots of depth to water versus time, with USGS gauging data superimposed, it is observed that rising groundwater levels coincide closely with the increasing stream height recorded at the upstream gauging station. In each source area, groundwater levels rose generally early morning of July 3.

In ***Source Area A***, about 0.2 to 0.3 feet of displacement occurred, with about 3 days needed for the displacement to recover.

In ***Source Area B***, approximately 0.2 to 0.3 feet of displacement occurred, with about 5 days needed for the displacement to recover.

In ***Source Area C***, about 0.7 to 0.8 feet of displacement occurred, with about 3 days needed for the displacement to recover.

In wells monitored near Holt Road, a subtle mounding effect is observed that is slightly staggered relative to the peak stream height. No more than about 0.2 feet of displacement occurred, with about 4 days needed for the displacement to recover.

In each ***Source Area***, the groundwater rise occurred rapidly, over a period of a just a few hours. Based on these rather abrupt changes in water level that occurred at wells grouped in a particular ***Source Area*** at roughly similar times, and with essentially the same magnitude of displacement in each area, it seems less likely that the cause is recharge from the ground surface, given that in places several feet of cohesive soil in the near surface would temporarily retard groundwater recharge. Rather, it appears to reflect a hydraulic response from the nearby creek system. It is noted that groundwater mounding was slightly more pronounced and rapid relative to the rising creek in ***Source Area C***. This would make sense, as this area is closer to the creek relative to ***Source Areas A*** and ***B***, located further west of the creek.

These observations suggest that a temporary losing stream condition relative to the surrounding upper aquifer system exists during periods of flood. Seeing how rapidly the wells recovered, the losing-stream event appears to only last as long as the elevated creek conditions; once stream flow drops toward base flow conditions, gaining stream conditions resume, and represent the default condition in this reach of Little Eagle Creek.

Data and associated selected daily potentiometric plots are provided in **Appendix I**. Prior to the rising stream flow, potentiometric contours depict flow across the site in a southeast orientation toward Little Eagle Creek. As the increased stream water load

passes, the net effect appears to temporarily (from July 2 to July 3) orient flow across ***Source Area A*** and ***C*** to the south. There does not appear to be a net shift of flow direction across ***Source Area B*** during this event. Within a day, however, as gaining conditions resume in the creek, flow reverts to a more southeasterly orientation. There is no evidence at all that indicates any significant or sustained mounding that would have significantly altered normal groundwater flow patterns over the study area..

*Injection Mounding Review*

During the 3rd injection round of field activities carried out in July 2013, some very limited, short-term mounding response was observed in selected wells very near (within 10 to 15 ft) to the injection locations. The mounding 'spikes', when they were observed, were present for no more than a couple of hours, and quickly dissipated. The noted maximum mounds were identified in:

- MMW-P-02: about 0.05 feet of mounding (***Source Area A***);
- MMW-P-12S and MMW-P-12D: about 0.05 feet of mounding (***Source Area B***);
- MMW-P-07: about 1.7* feet of mounding (***Source Area B***);
- MMW-10S: about 0.2 feet of mounding (***Source Area C***).

As indicated, the maximum mounding that occurred was no greater than about 0.2 ft at a distance of less than 15 ft from the injection points.

It should be noted that an anomalous reading of a 1.7 foot increase in water level height for a period of about one hour occurred in MMW-P-07 six days after the last ***Source Area B*** injections had been completed. Given the sudden rise and fall of this set of data, it is believed that these data are possibly related to a temporary fouling of the transducer due to sediment, or a surge in the transducer electronics, and not reflective of a mounding effect. However, if it is accepted that the brief rise in water level readings were somehow related to the injections, it occurred to the southeast of the injection area and was not sustained.

In summary, the hydraulic response of the aquifer during the 3rd round of injections was consistent with the previous analysis MUNDELL provided to IDEM, which indicated no significant mounding would occur during the injection activities, even in the immediate vicinity of the injections. In addition, whatever mounding was observed, would quickly dissipate within a few hours. The data collected during the 3rd injection also confirmed that the injections would not alter the sout-southeast groundwater flow direction from the Source Areas.

### 2.4.6 Summary of Horizontal and Vertical Extent of Contamination

#### 2.4.6.1 Soil

Based on soil analytical maps (**Figure 20a** and **Figure 20b**) and cross sectional diagrams (**Figure 5** through **Figure 7**), adsorbed cVOCs are present in vadose and saturated 'smear zone' soils in each of three *Source Areas*. Vadose impacts are restricted to discrete areas proximal to the historic Accent Cleaners tenant space (3819) and sewer lines in the *Source Areas*. Adsorbed 'smear zone' cVOCs are present in the saturated zone over a larger footprint along the sewer line path, encompassing all of the Source Areas. The most elevated adsorbed concentrations are generally found in the smear zone or beneath or at the water table and in some cases may be more indicative of groundwater impacts than soil impacts.

#### 2.4.6.2 Groundwater

Based on groundwater analytical data maps from the most recent quarterly/annual groundwater sampling (May 2013, **Figures 17a, 17b, and 18**, the current monitoring network generally delineates the horizontal and vertical extent of contamination in exceedance of applicable screening levels for the purpose of finalizing a site-wide remedial approach. It also serves to underscore the background component of cVOCs coming into the Site.

*Pre-Remediation Conditions*

As groundwater remediation has been occurring since August 2007, it is important to put into context pre-remediation trends in water quality. As previously presented in the 2008 RWP, figures depicting cVOC iso-contours (based on data collected through the 2005 FSI activities) are provided for review. These include **Figure 31a** for PCE in the shallow aquifer zone; **Figure 31c** for TCE in the shallow aquifer zone; **Figure 31e** for cis-1,2-DCE in the shallow aquifer zone; **Figure 31g** for VC in the shallow aquifer zone**; Figure 31i** for cis-1,2-DCE in the deep zone, and **Figure 31k** for VC in the deep zone. Please note, a figure was not prepared historically for TCE in the shallow zone because of its very limited extent at that time; a figure has been prepared for this report reflecting data available for the FSI in 2005. In addition, no figure has been prepared for PCE in the deep zone since no PCE has ever been detected in the deep zone throughout the Site.

As observed in **Figure 31k**, it is apparent that the pre-remediation condition for VC in the deep zone is present north of the Michigan Plaza area, and indicates that deep VC impacts from the Genuine Site had migrated through the Apartment and Plaza properties prior to any remedial activities.

*Current Conditions*

The data from the 2nd Quarter 2013 sampling event (May 2013) have been used as a basis for the plume isocontour maps shown in **Figure 31b** (PCE in shallow zone), **Figure 31d** (TCE in shallow zone), **Figure 31f** (cis 1,2-DCE in shallow zone), **Figure 31h** (VC in shallow zone), **Figure 31j** (cis 1,2-DCE in deep zone), and **Figure 31ll** (VC in deep zone). The current estimated extent of cVOCs reflect both the upgradient chemicals sources from the Genuine site as well as the active in-situ bioremediation sequential dechlorination remediation taking placed at the Site. As indicated in Section 2.4.1, the active in-situ bioremediation was initiated in August 2007 which began the process of sequential chemical dechlorination and, as such, chemical concentrations after that point in time reflect the efforts to reduce chemical concentrations through this process. The resulting transient chemical trends in some cases significantly decrease the observed concentrations (*e.g*., PCE) while temporarily increasing others (*e.g*., cis-1,2-DCE and VC) prior to full remediation.

These data also serve to underscore plume relationships between the Genuine site and Michigan Plaza. A description of each of the plumes is provided in the following paragraphs.

*PCE*

The core areas of dissolved PCE (present only in the shallow portion of the aquifer) are generally located adjacent to and hydraulically downgradient of the leaking sewer points and areas of vadose soil impact, thus generally confirming the source areas associated with the sewer impact linked to the former dry cleaner activities at 3819 West Michigan Street (see **Figure 31b**). With respect to exceedances of the RISC IDCL for PCE (*i.e*., areas greater than 55 ug/L), three shallow isolated pockets of PCE remain:

- On the Floral Park cemetery, just off the southwest corner of Michigan Plaza, in the vicinity of MMW-P-11S (*Source Area A*),
- South of Apartment Building No. 10 near MMW-8S (*Source Area B*), and
- Within the southwest portion of Apartment Building No. 1, near MMW-1S (*Source Area C*).

Exceedances of the RISC RDCL for PCE (which are the same values as the recently instituted RCG residential tap objectives) encompass a somewhat larger footprint in these areas:

- on the Floral Park cemetery, the area between MMW-P-11S to the southeast corner of the Plaza (*Source Area A*);

- the area between MMW-08S, MMW-P-12S, and MMW-P-01; south of Apartment Buildings Nos. 6 and 10 near MMW-8S (*Source Area B*), and

- From the southwest corner of Building No. 1 southeast to the intersection of Olin Ave and Michigan Street in the vicinity of ENVIRON well MW-168 (*Source Area C*), and likely a short distance beyond, toward Little Eagle Creek.

*TCE*

The areas of dissolved TCE associated with the drycleaner Source Areas (again, present only in the shallow portion of the aquifer) are contained within portions of the PCE residential exceedance footprints (see **Figure 31d**). Concentrations are below the RISC IDCL but above the RISC RDCL/RCG residential tap objectives in these areas.

A second area of dissolved TCE, unrelated to drycleaner activities, continues to migrate under Little Eagle Creek from the Genuine site, in the vicinity of the apartment swimming pool (near MMW-3S).

*Cis 1,2-DCE*

Dissolved cis 1,2-DCE is present in the shallow portion of the aquifer in the vicinity of and downgradient of *Source Areas B* and *C* (see **Figure 31f**). With respect to exceedances of the RISC IDCL for cis-1,2-DCE (greater than 1000 ug/L), it is present above this level in:

- the southern portion of the parking lot of Michigan Plaza near MMW-P-06 (*Source Area B*), and
- between the parking area for Building No. 1 and West Michigan Street near MMW-9S (*Source Area C*).

In Source Area B, cis-1,2-DCE is present above RISC RDCLs/RCG residential tap water objectives in the shallow portion of the aquifer in a footprint generally limited to Michigan Plaza. In Source Area C it extends from West of Building No. 2 southeast to the intersection of Olin Ave and Michigan Street in the vicinity of ENVIRON well MW-168. It appears to follow a degradation pathway as PCE is being converted to TCE then to cis 1,2-DCE.

In the deep portion of the upper aquifer (see **Figure 31j**), dissolved cis 1,2-DCE extends from the Genuine site under Little Eagle Creek below the Apartments. A co-mingled plume appears to be present in the vicinity of MMW-P-12D. However, it appears to terminate within the north-central portion of the Floral Park grounds directly south of Michigan Plaza and does not extend to Holt Road, Cossell Road, or Olin Ave.

Deep aquifer impacts indicate continued cis-1,2-DCE releases migrating onto the northern property boundary of the Apartments from the Genuine Site and being distributed more broadly across both the Apartments and Michigan Plaza properties. Elevated concentrations (maximum levels of greater than 350 ug/L) have been observed along the northern property boundary of the Apartments in wells MMW-4D and MMW-5D, and further downgradient into the Site in ENVIRON well MW-166D and MUNDELL well MMW-14D. Cross Section B-B' shown in **Figure 6** illustrates that these northern wells are screened along a deeper sloping till surface that is present beneath the upper till unit that underlies the three ***Source Areas*** at the Michigan Plaza site. This off-site plume appears to potentially migrate southward above and below the upper till unit.

*VC*

Shallow aquifer VC impacts are present across the majority of the Michigan Plaza property, with current maximum concentrations reaching 176 ug/L within *Source Area* A (MMW-P-03S), 2,040 ug/L within *Source Area B* (well MMW-P-08), and 420 ug/L within *Source Area C* (well MMW-9S). The shallow VC plume does not appear to extend much further beyond the west boundary of the Plaza (see **Figure 31h**).

Deeper VC groundwater impacts within the upper sand aquifer are more widespread and reflect a VC source coming onto the northern property line of the Apartments from the Genuine Site (see **Figure 31l**). Elevated historical concentrations (greater than 1000 ug/L) have been observed along the northern property boundary migrating onto the Apartments property. Deep VC impacts extend all the way to approximately MMW-C-17D, located near the maintenance building on the Floral Park grounds south of Cossell Road, and west to beyond Holt Road into the U.S. EPA monitoring well network. Based on the VC plume configurations across the study area, the elevated zone of VC present near Holt Road extends from the Genuine site along the western side of the apartment complex. This interpretation is supported by long-term, available historical trend data from Site monitoring wells MW-165D (farthest north), MW-166D, MMW-167D and MW-170D) which have all shown historical VC concentrations several orders of magnitude greater than their present values, and all pre-dating the Michigan Plaza bioremediation activities in August 2007 (see **Figure 31k**).

### 2.4.7 Summary of Vapor Intrusion Testing

A summary of the historic vapor intrusion testing activities is provided in **Section 2.2**. As a result of those investigations, MUNDELL installed indoor air mitigation systems at the Plaza in September 2006 and at the Apartments in 2008 per its own evaluation and IDEM's recommendation. The goal of these systems was to apply a vacuum on the sub-floor slab air environment and discharge the collected air to safe outside locations, thus

alleviating the indoor air quality concerns from subsurface chemical impacts at the Plaza and Apartments.

Relevant cumulative historical indoor air sampling results are summarized in **Tables 4a** and **4b** and mitigation system air samples are summarized in **Table 5**. Since the systems were installed, annual indoor air sampling events have demonstrated that concentrations of COCs inside the Plaza tenant spaces and in the Apartments have been and remain below 2012 IDEM Remediation Closure Guide Residential Levels and 2010 IDEM 25-year Commercial Levels as provided in the 2010 IDEM Draft Vapor Intrusion Pilot Program Guidance Supplement.

## 2.5 Summary of Human Health Risks Associated with the Site

The potential exposure pathways associated with the chemical impacts include:

- Air Inhalation pathway
- Groundwater Ingestion pathway
- Soil dermal exposure pathway

These will be discussed in more detail in the following section.

### 2.5.1 Conceptual Site Model and Exposure Pathways

The conceptual site model for risk evaluation for the Site identified the three chemical source areas (*Source Areas A, B and C*) located at the former drycleaning operations and along the sewer discharge from the Michigan Plaza as the primary source areas. The initial primary release mechanism was the discharge of solvent-containing wastewaters into the sewers, and then the leakage of the wastewaters from the sewer and infiltration into the subsurface soils and groundwater within an upper sand and gravel unit. The four COCs identified (PCE, TCE, cis-1,2-DCE and VC) have moved to a limited extent to the south-southeast from the discharge locations in the direction of groundwater flow.

It is anticipated that the Apartments portion of the Site will remain residential and that the Michigan Plaza portion of the Site will remain a commercial property for the foreseeable future. It is also noted herein that one of the Plaza tenants currently is a daycare facility. To the extent that the business is allowed to continue operation at the Plaza, it will be treated as a residential place with respect to cleanup goals.

No groundwater is actively being ingested on-site and downgradient off-site in the area of groundwater impacts. Ingestion of impacted groundwater associated with the Michigan Plaza-Apartments site is believed unlikely due to the lack of drinking water wells in the area located within the cVOCs footprint, the existence of an ERC on the properties restricting the future use of water, demonstrated groundwater flow direction (south-southeast) towards the Floral Park Cemetery property, the absence of

downgradient drinking water receptors, and the current No Well zone (NWZ) designation of this area by the Marion County Health Department. However, without an ERC that precludes the use of groundwater as a drinking water source, the potential exists for the accidental ingestion of groundwater by a future off-site user. In addition, it should be noted that there are drinking water receptors located in the homes to the west of the Site downgradient from the Genuine Site that obtain water from wells affected by VC and are not currently on City water. Several of these homes are on groundwater treatment systems supplied by the U.S. EPA and currently have had this exposure pathway controlled to an acceptable level. It is our understanding that the U.S. EPA plans to have all residents in the Holt Road area connected to City water and eliminate this exposure pathway. MUNDELL has previously explained that the VC plume affecting those homes does not originate from the Site and instead is from another source.

Surface water testing and plume delineation activities have determined no detectable impacts to Little Eagle Creek water quality and, as such, no ecological risks are foreseen.

One identified completed exposure pathway includes inhalation of on-site indoor air by current Michigan Plaza tenants and their customers and the Maple Creek Village residents. The installation of active vapor mitigation systems has reduced inhalation exposures for this pathway to acceptable risk levels while remediation is occurring. The potential also exists for off-site inhalation of indoor air resulting from impacted groundwaters.

The on-site inhalation pathway has been a human exposure pathway of concern, since concentrations of PCE and TCE in indoor air prior to the installation of vapor mitigation systems had consistently been detected above both draft U.S. EPA indoor air guidance levels and IDEM draft default vapor intrusion concentrations. However, with the installation of active vapor mitigation systems (see **Section 2.5.2**) this concern has been controlled to acceptable levels during the active remediation period.

### 2.5.2 Installation of Vapor Mitigation Systems

MUNDELL performed indoor air monitoring at the Michigan Plaza, which detected elevated cVOC levels as a result of vapor intrusion from the sub-slab area. MUNDELL installed indoor air mitigation system in Plaza Units 3801, 3811, 3819, and 3823 in September 2006. Full-time operation began on September 21, 2006. A follow-up indoor air sampling event to evaluate post-installation mitigation system effectiveness was conducted by MUNDELL in October 2006. The air mitigation systems had reduced the indoor air concentrations by about 95% of their previous concentrations and indoor air concentrations have met and continue to meet IDEM 2012 RCG IA residential levels. Therefore, the exposures from the inhalation of indoor air pathway have been reduced to acceptable risk levels as the remedial activities at the Site continue.

In 2008, three additional air mitigation systems were installed on the Apartments property in Building Nos. 1, 6, and 10 which had experienced historically elevated vapor intrusion levels. Since the installation of the mitigation systems, indoor air concentrations have been below cleanup goals. However, the air removed by the systems has been sampled on a quarterly basis and those analyses have revealed that PCE concentrations in air above the IDEM 2012 RCG IA residential levels are still being removed. Further reduction of PCE concentrations in groundwater (and as possible, in soil) will be required to minimize the future concerns for vapor intrusion.

It is anticipated that future institutional controls such as the recording of an additional ERC to require continued operation of vapor mitigation systems with periodic verification sampling in the event that indoor air cleanup goals are not achieved without an operating system.

## 2.6 Summary of Background Concentration Assessment

Groundwater and air are the two media that present background concentration considerations for this Site. Background concentrations of both cis-1,2-DCE and VC have been entering the northern property boundary of the Apartments since area groundwater monitoring began by Keramida in June 2001. Detailed monitoring by AMMH since August 2004 have indicated levels that have exceeded both RISC 2001 commercial/industrial and residential default cleanup levels (IDEM IDCLs and RDCLs), and now exceed 2012 IDEM RCG residential screening levels. This has allowed the cis-1,2-DCE and VC plumes to continue migrating farther downgradient from the Genuine source onto the Apartments and Plaza properties. With no efforts to actively remediate the Genuine impacts as they migrate onto the Site, even with both cis-1,2-DCE and VC concentrations decreasing somewhat over time, the Genuine contamination will continue to impact the Site. In addition, the presence of cis-1,2-DCE and VC in groundwater will need to be considered in determining appropriate cleanup goals when assessing the remedial efforts at the Site.

Based on a review of the March 2012 ENVIRON report, VRP Tier II (industrial) cleanup levels were established at the Genuine Parts site based upon the presumption that cleanup to Residential Cleanup Goals (RCGs) was not likely because of the presence of off-site sources (interpreted to mean source areas associated with Michigan Plaza). MUNDELL points out that source areas associated with Michigan Plaza are located well to the south of the Genuine Parts facility. Accordingly, there appears to be no reason why Genuine Parts could not achieve IDEM RCGs residential tap water screening levels at upgradient wells MMW-11D, MMW-13D, MMW-14D, MW-165D, MW-166D, MMW-4D and MMW-5D. Nevertheless, if IDEM does not require a more thorough remedial response for the remaining groundwater impacts migrating from Genuine Parts onto the Maple Creek Village property, concentrations coming onto the Maple Creek Village and passing into the remedial area for Michigan Plaza (*e.g.*, in upgradient wells MMW-11D, MMW-13D, MMW-14D, MW-165D, MW-166D, MMW-4D and MMW-5D) will be used as

'background concentrations' that will aid in distinguishing between the Michigan Plaza source impacts and the Genuine Site impacts.

Based on the wide distribution of cis-1,2-DCE and VC impacts in the deeper groundwater system from the Genuine site, MUNDELL believes that it is appropriate to use these background values as the target cleanup goals in the deeper portion of the surficial aquifer at the Michigan Plaza site.

With respect to background air concentrations, outdoor ambient air samples collected on the Plaza and Apartment properties have indicated that background concentrations of COCs during the last several years have been negligible. As a result, target cleanup goals for indoor air will still reflect the 2012 IDEM RCG Screening Levels for Commercial and Residential properties.

# 3.0 REMEDIATION PLAN

In order to determine an appropriate remediation plan for the Site, it is important to understand the relevant exposure pathways that are present or could be present as a result of the existing soil and groundwater cVOC impacts. This is determined by a comparison of the maximum existing soil, groundwater, and indoor air concentrations with those regulatory screening levels whose exceedance may indicate a potential unacceptable exposure condition. The **Inset Table 2** below provides the current 2012 IDEM Remediation Closure Guide screening levels used to assess this condition.

**INSET TABLE 2. 2012 IDEM Remediation Closure Guild Screening Levels**

| Chemicals of Concern | Soil | | | Groundwater | | Vapor Intrusion | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Direct Contact | | | Soil MTG | Tap | Groundwater | | IA | |
| | Res | C/I | Exc | Res | Res | Res | C/I | Res | C/I |
| | mg/kg | mg/kg | mg/kg | mg/kg | ug/L | ug/L | ug/L | ug/$m^3$ | ug/$m^3$ |
| **PCE** | 7.7 | 26 | 170 | 0.045 | 5 | 11 | 55 | 4.1 | 21 |
| **TCE** | 6.2 | 20 | 34 | 0.036 | 5 | 9.1 | 38 | 2.1 | 8.8 |
| **Cis-1,2 DCE** | 220 | 2000 | 2400 | 0.41 | 70 | - | - | - | - |
| **VC** | 0.84 | 17 | 660 | 0.014 | 2 | 2 | 35 | 1.6 | 28 |

Note: VI = Vapor Intrusion; Res = Residential; C/I = Commercial/Industrial; Exc = Excavation; MTG = Migration to Groundwater; IA = Indoor Air (2012 IDEM Remediation Closure Guide)

## 3.1 Exposure Pathways

Based on a comparison of these IDEM RCG screening levels with the maximum groundwater, soil and indoor air concentrations present at the Site using the data provided in **Tables 2 and Figures 20a** and **20b** for soil, **Table 3** and **Figures 31a** to **31l** for groundwater, **Tables 4a, 4b** and **Figure 21** for indoor air, and **Table 5** and **Figures 24a** through **24i** and **Figures 25a** through **25i** for subslab air, the relevant exposure pathways for the Site are:

- on-site and off-site **vapor inhalation**, and
- potential off-site **groundwater ingestion**.

For this RWP, the Michigan Plaza and Maple Creek Village Apartments are being considered together as "on-site" areas, but are nonetheless segregated because of their use as commercial and residential properties, respectively. While on-site soil and groundwater do contain cVOCs that exceed 2012 IDEM RCG C/I or Residential screening levels, exposure to them is controlled due either to existing site restrictions (*i.e*., no on-site drinking water wells are presently installed or will be installed) or the depth to the affected soils where contact would normally occur is too great. Therefore, the associated on-site dermal contact with soils and ingestion of groundwater exposure pathways are not complete.

Exceedances of 2012 IDEM RCG Indoor Air (IA) C/I and Residential screening levels, however, did exist prior to the installation of vapor mitigation systems and the initiation of in-situ bioremediation of groundwater at Michigan Plaza and the Apartments, and testing of the stack exhaust from those systems exceeds these levels. In addition, off-site concerns with impacted groundwater potentially causing either Vapor Intrusion (VI) issues at nearby residents or commercial properties, or the accidental ingestion of impacted groundwater from a commercial supply need to be addressed. Therefore, active soil and/or groundwater remediation efforts are needed to reduce contaminant concentrations for the aforementioned pathways to relevant cleanup goals.

To achieve these goals, the following primary and secondary remedial action objectives (RAOs) will be pursued:

### 3.1.1 Primary RAOs

The Primary RAOs are considered the minimum "priority" cleanup objectives in this section that need to be met prior to pursuing site closure, and will guide the continued pursuit of secondary RAOs, which may or may not need to be *completely* achieved in order to otherwise sufficiently address exposure risks associated with the Site COCs.

#### 3.1.1.1 Indoor Air – Michigan Plaza

- Indoor air (IA) at Michigan Plaza will be remediated to attain 2012 IDEM RCG IA Commercial/Industrial (C/I) screening levels without operating vapor mitigation systems and an ERC which precludes use of the facility leased space for daycare, or, if not achieved,

- To attain IDEM RCG IA C/I screening levels using active vapor mitigation systems with an ERC which excludes use of the facility leased space for daycare and requires the operation of active vapor mitigation systems.

#### 3.1.1.2 Indoor Air – Maple Creek Village Apartments

- Indoor air at Maple Creek Village Apartments will be remediated to attain IDEM RCE IA Residential screening levels without operating vapor mitigation systems, or, if not achieved:

- To attain IDEM RCG IA Residential screening levels using active vapor mitigation systems required by an ERC.

#### 3.1.1.3 Off-Site Shallow Groundwater – South of Michigan Plaza

Off-site shallow groundwater located to the south of the Michigan Plaza:

- Will be remediated to attain IDEM RCG Residential tap water screening levels without an Environmental Restrictive Covenant (ERC) on the Floral Park Cemetery, or, if not achieved:

- To attain IDEM RCG C/I VI Groundwater Screening Levels (GWSLs) with an ERC on the Floral Park Cemetery's property restricting the use of groundwater as drinking water and providing technical evidence in the Remediation Completion Report (RCR) that the remaining impacts in the shallow aquifer will not extend beyond the limits of the Floral Park Cemetery property at levels above residential tap water standards.

#### 3.1.1.4 Off-Site Deep Groundwater - South of Michigan Plaza

Off-site shallow groundwater located to the south of the Michigan Plaza:

- Will be remediated to attain IDEM RCG Residential tap water screening levels without an ERC on the Floral Park Cemetery property, or, if not achieved:

- To attain five times (5 x) the IDEM RCG C/I VI GWSLs with an ERC on the Floral Park Cemetery property restricting the use of groundwater as drinking water and providing technical evidence in the RCR that the remaining impacts in the deep aquifer will not extend beyond the limits of the Floral Park Cemetery property, or, if not achieved:

- To attain background levels associated with the deep Genuine plume entering the southern portion of the Maple Creek Village Apartments property.

### 3.1.2 Secondary RAOs

To minimize the need for permanent active institutional controls and associated monitoring, sufficient soil and groundwater remediation at the Site is proposed to reduce contaminant concentrations in the aforementioned pathways to relevant cleanup goals such that they remain below these levels without rebound. To achieve these goals, the following Secondary RAOs will also be pursued with the caveat that if:

- the Priority RAOs have been achieved but the following Secondary RAOs have not, and

- any residual hot spots in soil and groundwater have been reduced such that the potential for rebound in the exposure pathways has been adequately addressed,

then, final site closure will be granted by IDEM:

#### 3.1.2.1 On-Site Soil – Michigan Plaza

- Soil at Michigan Plaza will, as needed, be remediated to attain 2012 IDEM RCG soil migration to groundwater (MTG) screening levels, or until IDEM RCG IA C/I screening levels at Michigan Plaza have been achieved with or without operating vapor mitigation systems.

#### 3.1.2.2 On-Site Soil – Maple Creek Village Apartments

- Soil at the Maple Creek Village Apartments will, as needed, be remediated to attain IDEM RCG soil MTG screening levels, or until IDEM RCG IA residential screening levels at Maple Creek Village Apartments have been achieved with or without operating vapor mitigation systems.

#### 3.1.2.3 On-Site Shallow Groundwater – Michigan Plaza

On-Site shallow groundwater at Michigan Plaza:

- will be remediated, as needed, to attain IDEM RCG Residential VI GWSLs or IDEM RCG IA Residential screening levels, or, if not achieved:

- will be remediated to attain IDEM RCG C/I VI GWSLs with an ERC placed onto the property restricting use of tenant spaces to businesses that would be considered “commercial” in nature and not “residential” in nature (e.g., daycare or after school programs, etc.), or, if not achieved:

- will be remediated to attain IDEM RCG IA C/I screening levels with active vapor mitigation systems verified by periodic sampling and testing required by an ERC placed onto the property, and restricting use of tenant spaces to

businesses that would be considered "commercial" in nature and not "residential" in nature (e.g., daycare or after school programs, etc.).

#### 3.1.2.4 On-Site Shallow Groundwater - Maple Creek Village Apartments

On-site shallow groundwater at Maple Creek Village:

- Will be remediated, as needed, to attain IDEM RCG Residential VI GWSLs or IDEM RCG IA Residential screening levels, or, if not achieved:

- Will be remediated to attain IDEM RCG IA Residential screening levels with active vapor mitigation systems verified by periodic sampling and testing required by an ERC placed onto the property.

#### 3.1.2.5 On-Site Deep Groundwater – Michigan Plaza

On-Site deep groundwater at Michigan Plaza:

- will be remediated, as needed, to attain IDEM RCG Residential VI GWSLs or IDEM RCG IA Residential screening levels, or, if not achieved:

- will be remediated to attain IDEM RCG C/I VI GWSLs with an ERC placed onto the property restricting use of tenant spaces to businesses that would be considered "commercial" in nature and not "residential" in nature (e.g., daycare or after school programs, etc.), or, if not achieved:

- will be remediated to attain IDEM RCG IA C/I screening levels with active vapor mitigation systems verified by periodic sampling and testing required by an ERC placed onto the property, and restricting use of tenant spaces to businesses that would be considered "commercial" in nature and not "residential" in nature (e.g., daycare or after school programs, etc.), or, if not achieved:

- Will be remediated, as needed, to attain background levels associated with the Genuine plume entering the southern portion of the Maple Creek Village Apartments property.

#### 3.1.2.6 On-Site Deep Groundwater – Maple Creek Village Apartments

On-Site deep groundwater at the Maple Creek Village Apartments:

- Will be remediated, as needed, to attain IDEM RCG Residential VI GWSLs or IDEM RCG IA Residential screening levels, or, if not achieved:

- Will be remediated to attain IDEM RCG IA Residential screening levels with active vapor mitigation systems verified by periodic sampling and testing required by an ERC placed onto the property, or, if not achieved:

- Will be remediated, as needed, to attain background levels associated with the Genuine plume entering the southern portion of the Maple Creek Village Apartments property.

However, if these Secondary RAOs have not been fully achieved but the vapor inhalation and off-site groundwater ingestion goals have been achieved and the relevant exposure pathways eliminated or properly addressed, then final site closure will be pursued.

Depending on the actual exposure conditions and chemical trends that are present during active remedial activities, this RWP will also allow for the possibility of performing a site-specific risk assessment in order to select final cleanup objectives that are appropriate for the protection of human health and the environment.

**It should be emphasized that the activities of this VRP are not intended to remediate deep groundwater affected by the Genuine plume migrating below the Michigan Plaza and Maple Creek Village Apartments. As such, an assessment of the groundwater concentrations (and mass flux) coming into the Site from Genuine is essential to determine the ultimate appropriate cleanup goals.**

### 3.1.3 Ecological RAOs

The susceptible area assessment (see **Section 2.1.3 and Appendix D**) revealed that no critical or sensitive habitat is on-Site and no public water supplies are being threatened by the historic Accent Cleaners release. While private water supplies reportedly impacted by VC are located to the west and southwest of the Site across Holt Road, based on MUNDELL investigations, these locations are not receptors for groundwater migrating away from the Site, and in any event, they are being addressed separately by the U.S. EPA. As such, no special RAOs for critical or sensitive habitat are being proposed for the Site

## 3.2 Evaluation of Remedial Alternatives

Remedial alternatives were generally evaluated based on the five (5) criteria of primary concern outlined in Section 12.5 of the 2012 IDEM RCG. These include:

1) Effectiveness;
2) Cost;
3) Acceptability to affected parties;
4) Potential to make original situation worse;
5) Protectiveness of human health; and
6) Planned use of site and all affected properties.

Evaluated options for soil remediation consisted of:

- Excavation with off-site disposal;
- Excavation with on-site land farming;
- Soil vapor extraction (SVE);
- Dual phase vacuum extraction (DPE);
- In-situ chemical oxidation (ISCO);
- In-situ chemical reduction (ISCR), enhanced bioremediation, bioaugmentation; and
- Monitored natural attenuation (MNA).

Evaluated options for groundwater remediation consisted of:

- Pump and Treat;
- Air Sparging with/without ozone injection combined with soil vapor extraction;
- ISCO;
- ISCR, enhanced bioremediation, bioaugmentation; and
- MNA.

Description of the details considered for each of the technologies is provided below.

### 3.2.1 Soil Remediation – Excavation Options

#### 3.2.1.1 Soil Excavation with Off-Site Disposal

Based on the aerial extent of the residual absorbed cVOCs exceeding soil MTG screening levels at the Site, the on-site soil requiring excavation exists at all three Source Areas. The soil located in *Source Area A* is partially beneath the Plaza structure, making it very difficult to completely address via excavation. Additionally, the soil in *Source Areas B* and *C* are located in the vicinity of West Michigan Street and/or an active sanitary sewer line; excavation efforts would be very logistically challenging and prohibitively expensive in these areas.

Other complicating factors would include the presence of any buried structures, beyond the sanitary sewer line, sloughing soil, or the infiltration of excessive amounts of groundwater into deeper portions of the excavation (limiting the excavation depth to just below the groundwater table). MUNDELL would conduct a geophysical search for structures within the proposed footprint of the excavation. MUNDELL would have the excavation contractor provide equipment such as pumps and storage tanks to deal with infiltrating water, allowing the excavation to proceed to the needed depth. Also, installation of a temporary sewer bypass would be warranted as a precaution to excavate near the active sewer, the cost of which to install and maintain for the duration of excavation activities would be an added expense.

The main advantage of excavation would be the rapid timeframe for cleanup and removal of unsaturated and smear zone impacts that are acting as a continuing source of groundwater and possibly vapor impacts. The disadvantages of excavation would be the logistical ramifications of safely accessing soil below the 3819 tenant space without undermining load bearing features, removing the tenant temporarily or delays in waiting for a lease to expire, and health and safety concerns of the on-site workers would need to be carefully managed. Overall, the limited access to soils fails the criteria of technical feasibility.

#### 3.2.1.2 Excavation and Land Farming

Soil excavation with on-site land-farming requires an open, level area of sufficient size for treatment of the soil for at least two years. The Site has no open space to stage soil, making this option infeasible. In addition, land-farming is normally not considered for chlorinated compounds. Therefore, this alternative fails the technical feasibility criterion.

### 3.2.2 Soil Remediation - In-Situ Technologies

#### 3.2.2.1 Soil Vapor Extraction (SVE)

In-situ remediation of soils generally requires relatively permeable soils that allow movement of either air or water through the pore spaces. In addition, volatile constituents that are easily partitioned from the adsorbed phase to the vapor phase are most easily treated by this technology. The SVE process can be used to extract soil vapors from vadose zone soils. The most elevated soil concentrations at the Site are typically present within the smear zone of the groundwater surface, and thereby can be reasonably addressed with groundwater remedial approaches. Vadose zone impacts are present (mainly in granular soil below four (4) ft-bgs) below the former dry cleaner space (Unit 3819) and in the immediate vicinity of the sewer line leading from the rear of Michigan Plaza northward across Michigan Street and adjacent to the apartment complex. A significant amount of cohesive soil is present below the floor slab. SVE would be effective in volatilizing the COCs in granular material, but it would have some limitation in remediating any impact in cohesive soil. Based on a review of the soil data collected below the former dry cleaner space, the most elevated impacts are documented below four (4) ft-bgs. SVE can be considered a viable option for affected granular vadose zone, and seemingly can reduce or eliminate the potential need to excavate soil within the dry cleaner space. Therefore, SVE passes both technical feasibility and cost effectiveness criteria.

#### 3.2.2.2 Dual Phase Vacuum Extraction (DPE)

Dual phase vacuum extraction (DPE), also known as multiphase extraction, or MPE, is a process in which high airflow rates and high vacuum levels are used to physically remove the organic compounds from the subsurface soil. This process also removes groundwater from the subsurface, creating a cone of depression, thus allowing air to be extracted through more permeable soils. Dual phase vacuum extraction systems are most effective when hydraulic conductivity and groundwater volumes are low. These systems extract groundwater to depress the water table and expose the water-bearing unit. After the water-bearing zone is dewatered, vapors can be extracted from the exposed media. Dual phase vacuum extraction systems are capable of extracting groundwater, liquid and vapor phase hydrocarbons at the same time. The extracted fluids are then generally treated in an above-ground remediation system.

This approach would have similar drawbacks as SVE, such as the limited effectiveness in cohesive soil. Conversely, it has the advantage of being able to directly address groundwater. An additional disadvantage of DPE would be the need to treat and dispose of the large volume of extracted groundwater which would require a discharge permit. To operate effectively in an area with highly permeable saturated zones, DPE would need to be combined with groundwater pump and treat system to keep the target zone effectively dewatered. In addition, such a system would likely require many years of operation in order to achieve the desired cleanup objectives for soil, resulting in elevated capital and yearly operation and maintenance expense. Dual phase vacuum extraction therefore fails the evaluation criteria of technical feasibility and cost-effectiveness.

#### 3.2.2.3 In-Situ Chemical Oxidation (ISCO)

In-situ chemical oxidation (ISCO) involves the subsurface injection of reagents that are designed to destroy organic contaminants through chemical oxidation. The applicability of this technology relies to some extent on the permeability of the media being treated and the type of contaminant to be oxidized. The advantages of this technology are the potential for a rapid rate of reaction (*e.g.*, in some cases as little time as 20 weeks of treatment are required in optimal subsurface conditions), and the lack of the requirement for remaining on-Site treatment equipment for certain injection applications. The primary disadvantages of this technology are the high cost if repeated injections are necessary, the potential for health and safety concerns during treatment, and the lack of demonstrated effectiveness in some Indiana fine-grained soils. The ability to evenly distribute oxidizing chemicals throughout the soil matrix while the injected chemicals are ‘active’ is necessary for the successful application of this technology. ISCO is relatively ineffective on chlorinated ethanes, as summarized in *In Situ Chemical Oxidation: Performance, Practice and Pitfalls, AFCEE Technology Transfer Workshop, February 25, 2003*. Additionally, the relatively

low permeability of some affected vadose zone soils would likely reduce the efficiency of chemical injection and the effective distribution of the chemicals. Due to these reasons, ISCO is not a technically viable option.

#### 3.2.2.4 In-Situ Bioremediation and Bioaugmentation

Enhanced bioremediation involves injecting a catalyst into the vadose zone soil for the purposes of minimizing the leaching of mass into groundwater and enhancing natural biotic degradation of contaminants. Technologies such as VOS$^{TM}$ add a carbon substrate to soil to promote the growth of native micro-organisms that degrade cVOCs. These injection materials are specially designed to remain in place for extended periods of time and resist transport of cVOC mass into the saturated zone. The injections infuse carbon substrates into the unsaturated zones through multiple injection points to fill pore space, block off oxygen infiltration, provide moisture, and provide buffer and carbon material. In the process the source area undergoes reductive transformation and oxygen is consumed, maintaining reducing conditions.

The primary advantages of this technology are that it is relatively non-disruptive in nature, does not require on-going maintenance activities, and does not present a threat to human health or environmental quality. The injectant is able to maintain its position in the vadose zone due to its thixotropic qualities. Since impacted materials are not removed from the subsurface or treated and then disposed above the ground surface, there are no concerns with direct contact with the soil, and as such, no possibility of direct human or ecological exposure. In addition to the decreased risk of environmental impact by using this method, it also causes essentially no disturbance to the Site and surrounding area. The general disadvantages of this technology are that it is relatively new to the market with a somewhat unproven track record, and the fact that it does not so much 'treat' chemical mass in the soil as much as it either minimizes the leaching of the cVOCs into the groundwater, or as infiltration occurs, leaches with the cVOCs and provides a chemical environment for sequential dechlorination once they reach the groundwater. However, it does have the potential to leave mass in place in the vadose zone that that may pose some vapor intrusion concerns. Otherwise, it appears to represent a viable alternative for limited soil remediation.

#### 3.2.2.5 Monitored Natural Attenuation

Monitored Natural Attenuation (MNA) is the remediation of cVOCs by natural processes such as biodegradation, sorption, dispersion, volatilization, and dilution. The primary advantage of MNA is that it is a passive approach, requiring no mechanical equipment, instead relying on natural processes and long-term monitoring. The primary disadvantages of this method include the potentially long period of time needed to achieve cleanup goals, and the lack of control of degradation rates. To be considered for MNA, a site has to pass an

initial screening evaluation regarding the magnitude and extent of impacts, the type of contaminants, and the presence of any imminent threat to a receptor and the concentrations of groundwater impacts. Given that the primary COCs at the Site are chlorinated compounds, the Site does not appear to meet the conditions for MNA due to the potential leaching of adsorbed cVOCs from vadose soil into the groundwater. Based on these factors, natural attenuation alone cannot be considered a viable remedial technology for the soil at the Site.

### 3.2.3 Groundwater Remediation

As discussed in previous report sections, groundwater beneath the Site study area has been impacted by a plume of dissolved–phase cVOCs extending south-southeast from *Source Areas A, B*, and *C*. A second plume from the former Genuine property has migrated onto the Site, leading to a co-mingling of plumes in the southern part of the Apartments. Groundwater is present in permeable sand and gravel inter-bedded with cohesive deposits. Across the southern portion of the Apartment complex and Michigan Plaza, a laterally extensive till unit is present at depths between El 675 and 685 ft-MSL. Several monitoring wells at the Site are installed as nested pairs, with shallow wells screened across the top of the saturated zone and deep wells screened at or near the contact with the upper till unit. Several remediation technologies were evaluated for the treatment of these cVOCs from groundwater and are summarized as follows.

#### 3.2.3.1 Groundwater Pump and Treat

Groundwater extraction and treatment (a.k.a. “pump and treat”) is the process of pumping groundwater containing dissolved chemicals with recovery wells or trenches, passing the water through a treatment device (*e.g.*, air stripper, activated carbon, or sparging tanks) and discharging the treated water into a sewer, permitted discharge, or by re-injection on the upgradient side of the impacted area. The primary advantage of groundwater extraction and treatment is that it is a well-known technology by the regulatory community and it is able to exert hydraulic control of a plume rapidly by creating a capture zone downgradient of the impacted area. The disadvantages of this remedial technology include equipment operation and maintenance costs, the long periods of time that may be necessary to achieve cleanup goals, and the inability of the technology, in some cases, to achieve acceptable cleanup goals. In addition, large volumes of wastewater requiring permitting, treatment and disposal are generated. The large amounts of groundwater that would be extracted and treated and the relatively low solubility of some of the constituents of concern are additional factors that impact the technical feasibility, cost-effectiveness and treatment timeframe of this approach.

#### 3.2.3.2 Air Sparging (with Ozone Injection) and Soil Vapor Extraction (AS/SVE)

Air Sparging (with Ozone Injection) and Soil Vapor Extraction (AS/SVE) is the process of injecting a mixture of ozone and air below the groundwater surface and vacuuming air from the unsaturated zone above the groundwater surface to enhance the volatilization and removal of organic chemicals from subsurface soils and groundwater. The advantage of the technology is its general acceptance among consultants and regulatory personnel and proven track record for cleaning up sandy sites having groundwater impacted with VOCs, including chlorinated solvents and their breakdown constituents. Its primary disadvantages are the high capital equipment and operation and maintenance costs and its inability to effectively treat sites with clayey subsurface conditions. Because of the sandy vadose Site conditions and presence of VOCs, however, AS/SVE (enhanced with ozone) was considered a viable remedial technology for the Site.

#### 3.2.3.3 In-Situ Chemical Oxidation (ISCO)

The in-situ chemical oxidation (ISCO) process involves the subsurface injection of reagents (such as permanganate, hydrogen peroxide or ozone) that are designed to destroy organic contaminants through chemical oxidation, as already described in **Section 3.2.2.3** of the soil evaluation. ISCO can deliver a rapid treatment time when used in favorable conditions and is capable of treating contaminants present at high concentrations. There are several different technologies associated with ISCO, ranging from more powerful but shorter-lived oxidants to less powerful reagents with longer periods of effectiveness. The advantages and disadvantages of the use of ISCO are similar to those detailed for soil in *Section 3.2.2.3*, although additional drawbacks for use with groundwater may be the increased solubility of constituents treated with ISCO and harmful effects on native microorganisms present in the groundwater. In addition, the short-term reactivity of this alternative requires that treatment occur throughout the plume area and not via permeable reactive barriers. As such, access to all properties over a large land area that overlie the cVOC plume would be required to implement this alternative.

Our evaluation for groundwater treatment is similar to that for soil in that the recalcitrance of some of the ethenes to oxidation makes ISCO not suited for groundwater at the Site. In addition, the requirement of full access to the cVOC plume makes implementation of this alternative not technically feasible, and cost prohibitive.

#### 3.2.3.4 ISCR, Enhanced Bioremediation, Bioaugmentation

Enhanced bioremediation involves injecting a catalyst into the groundwater or smear zone soil for the purposes of enhancing natural biotic degradation of

contaminants. Technologies such as CAP18M®, HRC® and EOS® add a carbon substrate to groundwater to promote the growth of native micro-organisms that in turn degrade cVOCs through anaerobic respiration processes. The injections infuse carbon substrates into the saturated and smear zones through multiple injection points to promote anaerobic conditions and enhance microbial degradation of the cVOCs. It has been shown to be an economical alternative to an engineered system.

Bioaugmentation involves the addition of microorganisms to enhance the native population of chlorinated hydrocarbon degrading bacteria. Bioaugmentation is usually performed through injection and works best with aquifers that already have low levels of dissolved oxygen. Various formulations of bioaugmentation are available for use, with most including populations of *Dehalococcoides* (DHC), which has been demonstrated to completely degrade parent cVOCs to ethene. Groundwater can be sampled for DHC to determine the need for bioaugmentation and can also be sampled to confirm that bioaugmentation was successful. This technology is often used following carbon substrate addition to take advantage of the food source and anaerobic conditions provided by the substrate.

The primary advantages of this technology are that it is relatively non-disruptive in nature, does not require ongoing maintenance activities, and does not present a threat to human health or environmental quality. Since impacted groundwater is not removed from the subsurface or treated and then discharged above the ground surface, there are no concerns with direct contact with the water, and as such, no possibility of direct human or ecological exposure. In addition to the decreased risk of environmental impact by using this method, it also causes essentially no disturbance to the Site and surrounding area. The general disadvantages of this technology are the more significant initial cost, the potentially longer period of cleanup time required, and the need to monitor the aquifer geochemistry to ensure that conditions remain conducive for biodegradation. Its effectiveness is also limited to higher permeability water-bearing zones that are able to effectively and efficiently distribute the injectants. In-Situ bioremediation with CAP18ME™ and additional bioaugmentation with BAC-9™ followed by MNA is considered to be a viable combined technology for this Site.

#### 3.2.3.5 Monitored Natural Attenuation

MNA, as previously described in **Section 3.2.2.5**, involves the remediation of chlorinated solvents by natural processes such as biodegradation, sorption, dispersion, volatilization, and dilution. The primary advantage of MNA is that it is a passive approach, requiring no mechanical equipment, instead relying on natural processes and long-term monitoring. The primary disadvantages of this method include the potentially long period of time required to achieve cleanup

goals, and the lack of control of degradation rates. Typically, PCE and TCE tend to breakdown to daughter components best under anaerobic conditions, where cis-1,2-DCE and VC breakdown best under aerobic conditions. Given the shallow aquifer geochemistry at the Site (highly aerobic) and the observed persistence of PCE and TCE in the identified source areas. MNA alone will not likely facilitate the breakdown of these chlorinated compounds in the source areas at a rate that will result in the achievement of cleanup goals in a reasonable period of time. However, MNA (with Plume Stability Monitoring) following in-situ bioremediation and bioaugmentation is a viable option.

### 3.2.4 Remedial Evaluation Summary

In summary, the objectives of this proposed RWP are:

1) Fulfill the Primary Remedial Action Objectives (RAOs);

   - Achieve relevant IA Screening Levels for tenant spaces and apartments; and
   - Address potential off-site groundwater ingestion.

2) Fulfill the Secondary RAOs, if feasible:

   - Achieve relevant on-site soil screening levels for Michigan Plaza and the Apartments;
   - Achieve relevant off-site soil screening levels; and
   - Achieve relevant on-site shallow and deep groundwater screening levels for Michigan Plaza.

The nature of the COCs, the size of the cVOCs plume and the characteristics of the impacted soils and saturated zone make DPE and air-sparging either impractical or not cost-effective. Cleanup costs, site characteristics, and remedial timeframes make excavation and pump and treat options not practical. Plume stability is not an appropriate remediation option alone, since continued active remediation would still be necessary given the concentrations exceeding the exposure pathways. The type of constituents (*i.e*., the presence of many ethenes), along with the dechlorination already occurring in the groundwater is evidence that in-situ bioremediation and bioaugmentation of groundwater *alone* would be technically effective and cost-efficient as a primary remediation option.

Bioremediation and bioaugmentation of vadose zone soils also has the advantage of being the most efficient of the soil remediation options. Additional benefits of the bioremediation of vadose zone soils include overcoming many of the other difficult site-specific conditions listed above and removing the source of groundwater impacts as

well. Additional vadose zone treatment, however, may be required depending on the recalcitrance and leaching of the chemicals.

In addition to in-situ soil and groundwater bioremediation, air mitigations have been installed and will continue to be utilized in an effort to decrease air concentrations in affected apartment buildings and tenant spaces.

## 3.3 Selected Remediation Technologies

Based upon the:

1) The type, severity and extent of the COCs and associated risk exposure;

2) Site-specific operational constraints and land use;

3) Hydraulic, geochemical and physical characteristics of the aquifer, and

4) Economic factors,

in-Situ bioremediation via sequential reductive de-chlorination with CAP18 ME® with selected bioaugmentation with BAC-9™ followed by MNA remains the selected remediation technology for the Site for treating soil and groundwater. The contaminated (generally granular) vadose zone soils not able to be treated effectively by the CAP18 ME® injections have the option of being further addressed, if necessary, with a mobile SVE treatment system. While remediation progresses, sub-slab air mitigation systems have been previously installed and continue to operate during groundwater remedial activities to control and prevent the inhalation exposure pathway.

### 3.3.1 Remediation System Selection Factors

Given the reduction of risk from indoor air vapors accomplished with the current mitigation systems in place, the approach of substrate injection is more appropriate as an alternative corrective action method for the treatment of each of the source area plumes described in **Section 2.4** since there are no other current exposure risks from the site impacts. An in depth cost benefit analyses was performed of each viable option to further consider these alternative, the details of which are presented below.

#### 3.3.1.1 Remediation System Cost Analyses

Cost analyses summary of applicable remediation methods was performed, and is provided in **Appendix J.** The economic analyses showed that performing in-situ bioremediation with CAP18 ME® injections combined with an alternative option of the use of a mobile SVE unit to treat vadose zone soils with the

chemical Source Areas, if necesssary is the most cost effective approach to remediate the Site.

**Figure 32** shows the conceptual layout of the optional mobile SVE system.

### 3.3.1.2 Remediation System Practical Design Considerations

The injection of CAP18 ME® bioremediation product into contaminated areas in order to increase the productivity of the natural attenuation of impacted groundwater at the Site provides a non-disruptive, cost-effective means of protecting human health and the environment. As CAP18 ME® dissolves in groundwater, the triacylglycerols that compose the oil, hydrolyze into glycerol and fatty acids. Then, the native bacteria in the soil break down the CAP18 ME® unsaturated fatty acids into acetic acid and hydrogen ions through a process known as beta-oxidation. The extra hydrogen ions produced through this reaction increase the ability of the environment to naturally attenuate the contamination through reductive dechlorination. In-situ types of remediation technology are appealing in general because they eliminate human exposure to contamination and containment issues ensuing from transport, and they minimize disruption to Site activities.

The CAP18 ME® bioremediation product is appealing for several reasons as well. The primary reason is because of its effectiveness and longevity in comparison to other bioremediation products. Whereas other food-grade bioremediation catalysts such as molasses or whey last less than one month, CAP18 ME® has been proven to work for periods of 1 year, and in some groundwater environments, as long as 5 years. As such, its treatment capacity is much greater per pound of product than other catalysts. In addition, due to the low viscosity of CAP18 ME®, high pressure pumping is unnecessary, thus allowing for a greater distribution of the product in the subsurface at reasonable injection pressures if permeability is reasonable in the impacted aquifer material. This factor allows a wider spacing of injection points for the same treatment effectiveness and the use of standard direct push injection methods (*i.e.*, the use of a Geoprobe) for implementation of the approach.

The rationale for an optional mobile SVE system is based on the fact that:

- the potential exists for prolonged rebound of PCE in groundwater and/or indoor air vapor cleanup goals not being achieved due to the presence of PCE-impacted vadose zone soils within the chemical Source Areas;

- the extension of the time to cleanup or the need for permanent, active vapor mitigation systems as part of an ERC will result in added remediation costs beyond those required for the short-term use of an mobile SVE option;

- the PCE-impacted vadose zone soils are relatively limited in areal extent but widely spaced such that one (or two) permanent remediation systems with associated conveyance lines to reach all affected areas would be prohibitively expensive; and

- the PCE-impacted vadose zone soils in the Source Areas are generally conducive to allowing the establishment of an effective radius-in-influence (ROI) with SVE in a short period of time, allowing for the removal of significant adsorbed mass in a reasonable amount of time so that relevant cleanup goals can be reached during the remaining period of groundwater remediation. Because of this, a sustained vacuum operating continuously over months or years will not be required to achieve the needed remedial improvement in the subsurface.

For these reasons, short-term periodic mobilizations to widely-spaced areas is more cost-effective than otherwise installing a fixed SVE system requiring extensive conveyance reaches (in particular under Michigan Street) that would likely not be needed to operate for more than a year to achieve needed cleanup levels.

#### 3.3.1.3 Geochemical Treatability Study Prior to CAP18 ME™ Injections

To evaluate the suitability of the aquifer environment to continue to support future natural attenuation enhanced by the injection of CAP18™, the geochemical parameters of the groundwater at the Site have been evaluated during each quarter's groundwater sampling and monitoring event. These parameters are summarized in **Table 8**. The results of the sampling events indicated limited evidence of conditions that are naturally conducive to natural attenuation in the Source Areas. Dissolved oxygen (DO) concentrations in all of the Source Area wells monitored were above 2 mg/L; ORP values for all but one well were above 200 mV, and several of the locations had nitrate and sulfate concentrations large enough that there would be a reasonable amount of competition for reductive de-chlorination. The relatively lower ORP (-2 mV), DO (2.3 mg/L) and nitrate (<0.1 mg/L) however, showed strong evidence for anaerobic dechlorination potential near the Source Areas. As part of the consideration of this technology, the concept of driving the aquifer to an anaerobic condition by the injection of CAP18 ME® was considered to be theoretically viable. By taking away the available oxygen and making the hydrogen ions available, the PCE and TCE are able to breakdown under an anaerobic process, with the daughter products continuing to break down, or once the aquifer returns to an aerobic state, the aerobic degradation of those compounds will continue to naturally occur.

### 3.3.2 Groundwater Bioremediation Design and Implementation

In-Situ bioremediation and bioaugmentation involves injecting a bioremediation catalyst into the groundwater or unsaturated soil for the purposes of enhancing natural biotic degradation of contaminants. The bioremediation agent selected, CAP18 ME®, is a refined, food-grade soybean oil, produced by Carus Corporation (Carus), that stimulates anaerobic bioremediation of chlorinated hydrocarbons via a reductive dechlorination pathway. Additionally, the bioaugmentation agent selected, BAC-9™, is a microbial inoculant provided by EOS Remediation, LLC that enhances dechlorination by stimulating in-situ bioactivity and reducing the time required to grow the DHC bacterial population to effective cell densities.

The amount and distribution of CAP18 ME® needed for each *Source Area* was designed taking several factors into account as well as the practical experience of the manufacturers of CAP18 ME®, DBI Remediation Products, Inc, (DBI), and subsequently Carus. The amount of CAP18 ME® to inject into the chemical *Source Areas* was calculated for each injection event using the *Reagent Estimation Software* provided by the manufacturers. This software takes into account the treatment area volume (based on plume size) and the soil characteristics (type, bulk density, fraction of organic carbon, total and effective porosity, hydraulic gradient and conductivity). The spreadsheet then calculates the dissolved and sorbed contaminant demand, as well as the background demand from geochemical parameters (*i.e*., the site levels of dissolved oxygen, nitrate, manganese, iron, sulfate and hardness). Each of these parameters then factor into the stoichiometric demand for hydrogen, and the corresponding amount of CAP18 ME® needed for a particular treatment area. Microbial degradation and design contingency factors of safety are considered as well in the calculations. For this site, a factor of safety of 2 to 3 was selected to allow for degradation and design uncertainties.

Spreadsheet assumptions for the calculation of demand for CAP18 ME® for each *Source Area* and each injection event are shown in **Appendix K,** along with product information. Computations estimated that approximately the total amount of CAP18® or CAP18 ME® for each injection event has varied from 6.506 gallons for the 1st injection event, to 1,884 gallons for the 2nd injection event, and to 2,208 gallons for the 3rd injection event. Variations in quantities injected into each Source Area were calculated based on the indicator compound concentrations from 2007, 2009 and 2011, and geochemistry parameters during the same time periods.

Several iterations of CAP18 ME® injection distribution were evaluated using the *Reagent Estimation Software* and considering Site physical features. The first consideration was to determine what type of application would best fit the plume's size and distribution in each *Source Area* given the geology, geochemistry and indicator compounds. The saturated zone within each *Source Area* has a poorly-graded, medium sand (SP) underlain by a well-graded, gravelly sand (SW). Conventional experience with CAP18 ME® in sands confirms that fatty acids that get broken down through beta-oxidation can travel distances as great as 75 to 100 feet from the place of injection, thereby allowing "treatment" to continue downgradient as the fatty acids migrate and continue to lend

hydrogen atoms for reductive dechlorination. Given this geologic advantage and the plumes being situated as they are in relation to Michigan Street and the Plaza building, it was determined that a 'treatment curtain' design distribution would be effective in some areas.

The injection spacing for the selected design is largely determined by the aquifer's ability to receive the product. An injection spacing of 10 to 15 feet on centers is considered very effective for the sands encountered at the Site, with curtain 'rows' often stacked two to three deep for each curtain area. Curtain areas were generally aligned along sewer location where impacts were noted, or perpendicular to either the plume or parallel with building walls that controlled injection accessibility. Injection points along each curtain row were spaced approximately 10 to 15 feet apart, with adjustments between rows to allow the most even distribution of vector lines downgradient from injection points. This configuration was designed to provide the most thorough coverage per *Source Area*. After the number of points was established per *Source Area*, the total oil demand for each *Source Area* was divided by the number of points. Design loading estimates with conceptual layout was drafted and discussed with IDEM (see reports provided in **Appendix K**). This design accounted for injecting the CAP18 ME® conservatively throughout the smear zone and saturated zones above the laterally extensive upper till unit encountered between 675 and 685 ft-MSL at each injection point.

IDEM approved CAP18 ME® injections in a *Review of the Response to Comments on the Third Round of CAP18ME™ Injections* letter dated June 3, 2013 (provided in **Appendix A**).

A concern that has historically been raised by U.S. EPA regarding injections (see the March 27, 2011, *Technical Memorandum* prepared for the U.S. EPA by Weston) is that the liquids injected by MUNDELL during the two previous vegetable oil injections in 2007 and 2009 could potentially drive the groundwater flow in the direction of the Holt Road residences by creating a mounding affect. MUNDELL has responded to this concern in previous Technical Response documents. A detailed analysis of the measurements and observations made during the 3rd injection round in July 2013 is provided in **Section 2.4.5**. The following summarizes the injection quantities and rates for the first two injection events:

**2007**

- Total Injection Quantity = 6,506 gallons
- ***Source Area A****:* 1,962 gallons CAP 18™ over 8 days of field time.
  - about 250 gallons per day.
- ***Source Area B****:* 2,815 gallons CAP 18™ over 12 days of field time.
  - about 234 gallons per day.
- ***Source Area C****:* 1,729 gallons CAP 18™ over 5 days of field time.
  - about 342 gallons per day.

**2009**

- Total Injection Quantity = 1,884 gallons
- ***Source Area A**:* 455 gallons CAP 18 ME™ over 2 days of field time.
  - about 228 gallons per day.
- ***Source Area B**:* 585 gallons CAP 18 ME™ over 2 days of field time.
  - about 292 gallons per day.
- ***Source Area C**:* 844 gallons CAP 18 ME™ over 2 days field time.
  - about 422 gallons per day.

**2013**

- Total Injection Quantity = 2,208 gallons
- ***Source Area A**:* 255 gallons CAP 18 ME™ over 2 days of field time.
  - about 127.5 gallons per day.
- ***Source Area B**:* 1,194 gallons CAP 18 ME™ over 4.5 days of field time.
  - about 256.3 gallons per day.
- ***Source Area C**:* 759 gallons CAP 18 ME™ over 3.25 days field time.
  - about 233.5 gallons per day.

These quantities and injection rates indicate average injection rates of between 0.16 to 0.53 gallons per minute (gpm), or average rates well less than a small, low-flowing garden hose. Actual measurements of impact in the surrounding monitoring wells indicated no groundwater level mounding effects beyond 10 ft from the injection points during the injections. The design called for a 10 ft radius of influence for the vegetable oil itself.

During the most recent third injection event (July 2013), MUNDELL completed additional gauging prior to, during, and subsequent to injections. The results are summarized in **Section 2.4.5**. Mounding effects that would have altered groundwater flow did not occur.

### 3.3.3 Optional Soil Remediation Via Mobile Soil Vapor Extraction

Based on the preceding review, the selected optional primary remedial approach to address the remaining soil vadose zone is soil vapor extraction (SVE) technology. The SVE application would be focused on remediating vadose soil in the vicinity of the Source Areas where vadose impact has been identified. Because of the small, isolated pockets of vadose zone impact along and below the sewer runs, and below the former dry cleaner tenant space, and based on the permeable nature of the sand material and MUNDELL's experience in applying SVE technology in similar permeable deposits across Indiana, a pilot study was not deemed necessary to derive a conservative radius of influence (ROI) that should be adequate for extraction well design purposes.

MUNDELL conservatively estimates a ROI of 30 feet with an appropriately spaced set of extraction wells will provide adequate coverage of affected areas. The proposed SVE system layout is illustrated on **Figure 32**.

It is anticipated that, based on the generally granular nature of the subsurface material below the former drycleaner tenant space at depths of typically 4 to 7 ft bgs, the SVE system should be able to adequately remediate soils under the building, avoiding the need to consider soil excavation. However, it is proposed that a monitoring point be installed in the tenant space so that vacuum measurements can be made to verify the extent of SVE influence in this area. If exterior extraction wells do not provide an influence below the tenant space, an additional extraction point within the tenant space may need to be installed and plumbed into the exterior conveyance line.

### 3.3.4 Vapor Intrusion Mitigation System Design and Implementation

MUNDELL installed indoor air mitigation systems at the Plaza in September 2006 and at the Apartments in 2008. The goal of these systems was to apply a vacuum on the sub-floor slab air environment and discharge the collected air to safe outside locations, thus alleviating the indoor air quality concerns from subsurface chemical impacts at the Plaza and Apartments.

#### 3.3.4.1 Indoor Air Mitigation System Design

MUNDELL assessed various types of sub-slab depressurization units, from various companies, with various installation applications. Ultimately, a centrifugal in-line regenerative blower (RP-145 series), with design specifications indicating a range of 73 to 173 cubic feet per minute (cfm) was chosen to effectively capture vapors from beneath the buildings.

#### 3.3.4.2 Indoor Air Mitigation System Installation

Four (4) sub-floor slab depressurization units were installed by *Air Quality Control (AQC)* under the oversight of MUNDELL from September 14 to 21, 2006. Three (3) additional sub-floor slab depressurization units were installed by AQC under the oversight of MUNDELL on March 19 and 26, 2008. A unit/blower was installed in the following spaces at Michigan Plaza: Village Pantry (B-1), veterinary clinic (B-2), the Arca de Salvacion (B-3), and laundromat (B-4). In 2008, a unit/blower was also installed in Apartments Building No. 1 - Basement Apartment 101 (B-5), Building No. 6 – Basement Apartment 602 (B-6), and Building No. 10 – Basement Apartment 1001 (B-7). The system locations are illustrated in **Figure 32**.

The system installation involved coring through the slab in each of the four spaces with a ‘Bosch’ hammer drill (see **Appendix L: Photo 2**). A ‘vapor collection chamber’ (see **Appendix L: Photo 1**) was created beneath the

concrete floors at pre-selected locations. It was confirmed that there was porous material (pea-gravel) in the vicinity of the collection chamber in order to achieve maximum suction of the sub-slab vapors (see **Appendix L: Photo 3**).

Plastic vent pipes were installed into the collection chambers and the suction points were sealed in place in the concrete floor (see **Appendix L: Photo 5**). Primary suction pipes ran from the collection chambers to the nearest outside wall. The blowers were installed on the exterior and the exhaust pipe was continued to the roofline (safe discharge locations) (see **Appendix L: Photos 6** and **10**).

Differential pressure gauges were installed on pipes to monitor/display fan vacuum pressures (see **Appendix L: Photos 4** and **11**). Individual power circuits were installed to supply power for each of the blowers. Sampling ports were also installed onto the suction pipes to enable monitoring and the collection of system samples in the future.

#### 3.3.4.3 Indoor Air Quality Testing

Follow-up indoor air sampling events to evaluate post-installation mitigation system effectiveness continue to be conducted by MUNDELL. Quarterly air sampling events consist of collecting air samples from the seven (7) air mitigation systems. Annual sampling events include additional 24-hour indoor air sampling conducted at the six units within Michigan Plaza, as well as inside Apartment Buildings Nos. 1, 6, and 10.

The analytical results of the indoor air quality sampling at the Site are summarized in **Tables 4a** and **4b.** As of the last Summa Canister testing in May 2013, the air mitigation systems had reduced the indoor air concentrations by about 95% of their previous concentrations and the indoor air concentrations met 2012 IDEM RCG Indoor Air (IA) commercial/residential screening levels. Quarterly samples collected from the discharge of each system have shown overall concentration trends generally decreasing throughout the time period of 2007 to 2013. Quarterly sampling of these discharge points has continued to show decreases (as seen on **Table 5**), so there are several indications the concentrations have been effectively reduced and the systems are effectively mitigating the inhalation exposure pathway at the Plaza building as well as the Apartments. The collection of annual indoor air samples will continue to quantify the continued reductions with laboratory analytical testing inside the units. **Appendix M** contains calculations of cVOC volumes removed during the various systems operations.

#### 3.3.4.4 Indoor Air Mitigation System Monitoring

As a means of System Operation and Maintenance, Photo Ionization Detector (PID) readings and system sample collection and analysis will be performed by MUNDELL on a quarterly basis in order to track the levels of chemical constituents being removed by the system. The static pressure readings will also be monitored as a part of the system operation and maintenance (O&M) in order to ensure optimal suction by the blowers.

### 3.3.5 Remediation Technology Description and Startup

#### 3.3.5.1 CAP18 ME® Injection Protocol

During July 2013, the third round of CAP18™ injections at each injection point used the following protocol:

1) At each injection point, the Geoprobe™ direct pushed the drill rods down to the bottom depth. Total depths for each point were determined prior to injections based on previous injection logs and historical subsurface investigations. Water level data were collected using transducers (one reading per minute) at nearby wells one week prior to initiating injections and throughout the injections.
2) Injections occurred from the top down in 3-foot lifts, with the top lift being anywhere from 1 to 3 feet above the observed water table (to account for seasonal fluctuations), and the bottom lift being just above or slightly into the top of the upper clay till located between El 675 and El 685 ft-MSL.
3) The total poundage of CAP18 ME® and BAC-9™ loading designed per boring was predetermined for each location. Larger volumes were injected into the upper portions of the saturated zone as compared to greater depths. Additionally, larger volumes were injected into the highest concentration areas of the indicator compounds compared to the plume perimeters. This allowed for a longer period of activity from the presence of CAP18 ME® and its fatty acids in those areas, increasing their effectiveness. Thus, larger masses of CAP18™ injection loading were distributed in the more central areas of each *Source Area* plume to ensure the most longstanding availability of hydrogen for reductive de-chlorination. **Figure 26c** shows the final injection design layout and loading.
4) A 5-gallon bucket was used to load the CAP18 ME® from the tote into a hopper to stage the CAP18 ME® prior to delivery into the borehole. Graduations were put on both the 5-gallon transfer bucket and the hopper so as to keep track of quantities. BAC-9™ was added in-line to the CAP18 ME® feed line to the hopper in a similar fashion using a 1L-cylinder.
5) CAP18 ME® and BAC-9™ was then pumped from the hopper using a Geoprobe™ grout system (GS-1000 series), through tubing sealed and

connected to the tooling rods down into the bottom of the drill rods, where it was slowly injected under pressure into the formation at the 3-foot lift intervals and loading requirements established above. A minimal residence time was maintained in the hopper so that exposure to air was minimized. Lines were flushed with anaerobic water between lifts.

6) Following injections, the boring annular space was backfilled with bentonite chips and (as needed) a surface asphalt patch.

#### 3.3.5.2 Soil Vapor Extraction

1) If selected as a soil remediation alternative option, SVE extraction wells will be installed at the locations illustrated on **Figure 32.** The wells will be constructed of 4-inch diameter PVC riser and screen. The screens will be either 10 to 15 feet in length, with the base of the well set just above the approximate high water table position (screened across vadose zone). Each cluster of wells will be manifolded together to a single access point via a 4-inch diameter conveyance line.

2) The access point will be housed in a either a flush-mount 2-ft by 2-ft manway vault or 8-inch diameter manhole with wellpad.

3) Periodic SVE events (bimonthly or quarterly) utilizing a mobile SVE unit are proposed for the Site. The SVE system will be housed in a mobile trailer unit that will be parked at four discrete areas across the Site. At each area, two to three extraction wells will be manifolded by either hoses or short conveyance line segments located in a central limited access manway vault to the system. The system requires 220v power.

4) MUNDELL will explore the feasibility of providing power line drops to each staging area (the current owner is acceptable to this). Alternatively, the option of utilizing a generator staged adjacent to the trailer will be explored.

5) At each location, the SVE unit will operate for up to five continuous business days.

6) During the events at each location, periodic vacuum readings will be collected. Samples of effluent vapor will be collected as well.

#### 3.3.5.3 Health and Safety

Prior to CAP18$^{TM}$ injections, MUNDELL prepared a Health and Safety Plan to ensure that activities for remediation would be conducted with industry standard safety measures, and that the surrounding public would not be threatened by any of the activities the occurred. A copy of this HASP is provided in **Appendix N.**

Prior to all drilling operations, MUNDELL called Indiana Plant Protection Service (IUPPS) for utility locates in the specific areas being drilled. As a supplement to this utility locate, MUNDELL also utilized its own geophysics department to provide more in depth locates of utilities and obstructions. Proposed locations were adjusted slightly whenever necessary.

As an additional safety measure for the on-site storage of CAP18 ME®, a chain link fence was erected behind the Plaza to store totes of CAP18 ME® (2100 lbs net weight each). The fence area was locked overnight during the duration of CAP18 ME® injection applications.

#### 3.3.5.4 Permitting

There will not be any ongoing water discharge or air emissions requiring a permit during remediation activities.

It is anticipated that air discharge permits for the SVE systems will not be needed due to the low mass volumes that will be generated over the course of a year. MUNDELL will re-evaluate the possible need for a permit following collection of initial effluent data.

#### 3.3.5.5 Disposal

All soil cuttings generated during well installation were disposed at a permitted waste disposal facility under the current soil profile. Copies of soil disposal manifests associated with remediation implementation activities will be provided in an associated *Remediation Completion Report*.

## 3.4 Risk Assessment

There have been several assessment activities performed to investigate the potential risks that may be present from chemical release(s) at the Site since 2002. Several Indoor Air Studies have been conducted by MUNDELL at the Apartments and the Plaza (2002, 2003, 2004, and 2006), and throughout the course of these studies and the subsurface investigation work MUNDELL has conducted, the following exposure pathways have been evaluated:

### 3.4.1 Groundwater Ingestion Exposure Pathway

Although this is not currently a complete exposure pathway, since no on-site or downgradient residential or industrial wells have been identified, it is considered a *potential* future complete pathway by IDEM, unless a permanent deed restriction or municipal ordinance is permanently put in place at Floral Park cemetery to prevent the consumption of groundwater as drinking water. An ERC

has been placed on the Plaza and Apartments properties that restricts the use of groundwater as drinking water. In addition, the Site is located within one of seven Marion County Health Department (MCHD) No Well Zone (NWZ) Areas. As such, future permits for water supply wells will be reviewed and limited by the MCHD until identified impacted groundwater in the general area is remediated and groundwater quality is restored to a drinkable condition. Therefore, additional risk analyses at this time were determined to be unnecessary, and were not performed for this Site for this exposure pathway. As indicated in **Section 1.3.1.3** and **1.3.1.4,** risk analysis at the time of submittal of the Remediation Completion Report (RCR) will be provided, if necessary, to demonstrate that the remaining cVOC groundwater concentrations will not extend beyond the Floral Park Cemetery property at concentrations above the IDEM RCG tap water screening levels.

### 3.4.2 Dermal Exposure Pathway

This is not currently a complete exposure pathway in the Site conceptual model, as there is no ongoing direct contact with the soils or groundwater impacts, and the remaining cVOC (primarily PCE) soil impacts detected are below the 2012 IDEM RCG direct contact excavation screening levels (see **INSET TABLE 2**) that would present a concern to construction workers should soils require excavation in the future. In addition, the surface water sampling performed in Little Eagle Creek at locations downgradient of the plume across Olin Avenue all showed no indication of chlorinated solvent impacts, so there is no direct exposure via surface waters. Lastly, standard dermal exposure risk calculations for the four COCs (PCE, TCE, cis-1,2-DCE and VC) have indicated that significantly high concentrations for dermal contact would be required to generate an unacceptable risk (greater than $1 \times 10^{-5}$ excess cancer risk), several orders of magnitude less than the proposed cleanup goals. Therefore, additional risk analyses were not determined to be necessary for dermal contact, and were not included for this Site for this exposure pathway.

### 3.4.3 Inhalation Exposure Pathway

This is an identified human exposure pathway of concern, since concentrations of PCE and TCE had historically been detected in indoor air in the Plaza and Apartments prior to the installation of vapor mitigation systems above draft U.S. EPA and IDEM indoor air default levels. Data and evaluation of these indoor air concentrations was provided in the *Further Site Characterization Report* (MUNDELL, 2006b). Remediation of this exposure pathway is further discussed in **Section 3.1**.

## 3.5 Community Relations Plan

AMMH and MUNDELL have managed site investigation and remediation activities with ongoing communication to the residents, tenants and adjacent property owners consistently throughout the project. Pursuant to Indiana Code (IC) 13-25-7, a Community Relations Plan has been formally prepared in accordance with the IDEM Office of Land Quality non-rule policy document Waste-0049-NPD. The purpose of the plan is to ensure the surrounding community will continue to be made aware of the history, status of the project, and remediation activities at the above-referenced Site so that there continues to be community participation and attentive response to public questions. The plan documents community relations that have been completed to date and outlines additional steps to update and enhance such communication such that that the ultimate goal of protecting human health and environmental quality is met and understood. A copy of this community relations plan is provided in **Appendix O.**

## 3.6 Monitoring and Sampling Plan

A monitoring and sampling plan has been established for the groundwater monitoring and indoor air monitoring to track progress of the remediation. The Quality Assurance Project Plan (QAPP) for this project was provided in the *Further Site Characterization Report* (MUNDELL, 2006b). These monitoring and sampling activities are proposed, and are subject to change based on IDEM's review and site conditions.

### 3.6.1 Groundwater Monitoring Program

Groundwater monitoring activities will consist of quarterly groundwater sampling of the twenty-eight (28) monitoring wells established with IDEM, twelve (12) additional MUNDELL monitoring wells on the Floral Park Cemetery property, and six (6) ENVIRON monitoring wells, for a total of forty-six (46) groundwater monitoring wells sampled on a quarterly basis. The following constitute this quarterly groundwater monitoring network:

***MUNDELL monitoring wells (40 total)*:**

*Michigan Plaza and Vicinity (15):*

MMW-P-01, MMW-P-02, MMW-P-03S, MMW-P-03D, MMW-P-04, MMW-P-05, MMW-P-06, MMW-P-07, MMW-P-08, MMW-P-09S, MMW-P-09D, MMW-P-10S, MMW-P-10D, MMW-P-12S, and MMW-P-12D.

***Maple Creek Village Apartment Complex (13)*:**

MMW-1S, MMW-4D, MMW-6D, MMW-8S, MMW-9S, MMW-10S, MMW-11S, MMW-11D, MMW-12S, MMW-13D, MMW-14D, MMW-15S, and MMW-15D.

***Floral Park Cemetery (12)*:**

MMW-C-01, MMW-C-02S, MMW-C-02D, MMW-C-16S, MMW-C-16D, MMW-C-17D, MMW-P-11S, MMW-P-11DR, MMW-P-13S, MMW-P-13D, MMW-P-14S, and MMW-P-14D.

***ENVIRON monitoring wells (6)***:

MW-167S, MW-167D, MW-168S, MW-168D, MW-170S, and MW-170D.

MUNDELL proposes to add ENVIRON well MW-171S to the quarterly sampling network, or alternatively install a new well in this approximate location to evaluate conditions further downgradient of *Source Area C*.

In addition to collection of groundwater levels from each of these monitoring wells, MUNDELL will measure groundwater levels from four nests of Keramida monitoring wells surrounding the Plaza Property for the purpose of more accurately determining the groundwater flow direction and gradient over this wider area. The following additional wells will have their groundwater levels measured each quarter:

***Maple Creek Village monitoring wells****:*

MMW-2S, MMW-3S, MMW-7S, and MMW-5D.

***ENVIRON monitoring wells****:*

MW-166S, MW-166D, MW-169S, MW-169D, MW-171D, MW-174S, MW-174D, MW-175S, and MW-175D.

Surface water elevations will be directly measured at the following locations:

***Little Eagle Creek Stream Gauge Locations****:*

SG-1 and SG-2. (at the bridge crossings along Holt Road and Michigan Street, respectively).

MUNDELL has historically measured static groundwater elevations at thirteen (13) U.S. EPA wells. However, changes in the U.S. EPA's funding prevented MUNDELL from gaining access to those wells beginning in the second quarter of 2013. If the U.S. EPA obtains additional funding, MUNDELL will also gauge the following wells quarterly:

***US EPA wells****:*

MW-WES-01A, MW-WES-01B, MW-WES-01C, MW-WES-02A, MW-WES-02B, MW-WES-02C, MW-WES-03A, MW-WES-03B, MW-WES-04A, MW-WES-04B, MW-WES-05A, MW-WES-05B, and MW-WES-05C.

For at least the next two years post-injection period, groundwater samples will be submitted to Pace Analytical Laboratories for VOC analysis via U.S. EPA SW-846 Method 8260, along with appropriate duplicate (DUP), matrix spike (MS) and matrix

spike duplicate (MSD). Baseline groundwater geochemical parameters (pH, dissolved oxygen, oxidation-reduction potential, conductivity, and temperature) will be measured with a low-flow cell and multi-parameter water quality probe throughout the first two years of the post-injection period to evaluate whether aquifer conditions continue to be favorable for natural attenuation of the indicator compounds at the Site. Additional geochemical parameters (nitrate, sulfate, ferrous iron) will be performed quarterly during the first year post-injection period in a minimum of three monitoring wells per *Source Area* so as to obtain data inside and outside the aquifer treatment zone. Nitrate analyses will be performed by Colormetric Method 352.1, and Sulfate Analyses will be performed by EPA U.S SW 846 Method 9038, both by Pace. A field Colormetric Hach Method 8146 test kit will be used to collect ferrous iron (Iron II) readings during all sampling events, which will be compared with the total Iron results collected pre-injection in each *Source Area*.

Additional aquifer parameters including methane, ethene, and ethane will be analyzed to evaluate indicator compound breakdown and redox-sensitivity. In addition, volatile fatty acids (VFA) will continue to be analyzed to evaluate substrate distribution and lifetime duration of the product. These samples will be collected in select monitoring wells representative of each plume to monitor the presence of residual CAP18 ME® in the aquifer and to provide additional monitoring of aquifer conditions. Future monitoring of these constituents will be performed as needed to evaluate the natural attenuation process.

In addition to the forty-six (46) groundwater monitoring wells that are sampled on a quarterly basis, and the one additional well (MW-171S or equivalent) proposed to be added (47 total), an additional eight (8) groundwater monitoring wells will be sampled on an annual basis, as established with IDEM on May 25, 2007 for the purpose of monitoring the wider surrounding aquifer conditions emanating from Genuine. The following lists these additional wells:

*MUNDELL monitoring wells*: MMW-2S, MMW-3S, MMW-5D, and MMW-7S.

*ENVIRON monitoring wells*: MW-169S, MW-169D, and MW-171D.

A table listing the proposed monitoring and sampling program monitoring wells, analytical methods and frequency is included as **Table 9.**

### 3.6.2 Off-Site Residential Sampling – Soil Gas

As a means of evaluating potential VI concerns at the residences to the west of Michigan Plaza (along Michigan Street), MUNDELL has previously attempted on several occasions to gain access to the residences, without success. However, in July 2013 the resident located closest to the intersection of Holt and Michigan Road indicated they would allow partial access to install a soil gas point in their driveway. MUNDELL will coordinate this activity in the fall of 2013.

### 3.6.3 Air Mitigation System Monitoring Program

As part of the continued Air Mitigation System Monitoring Program, MUNDELL will continue to monitor the discharge air at each of the units at the Plaza, both with a PID and analytical testing. In addition to this quarterly sampling, indoor air samples will be collected annually. If vapor concerns are not able to be permanently eliminated through the previously completed and proposed remedial effort, including the current groundwater remediation or optional SVE soil remediation, some form of permanent engineering control will be considered, if necessary.

Prior to the operation of the optional mobile SVE system, it is recommended that a set of pre-SVE baseline air sampling occur from the mitigation system sampling points within one week prior to system operation, providing a starting reference point regarding vapor quality across the site. It would also be beneficial to collect a set of samples from soil gas wells MGW-01, MGW-02, and MGW-05 (and any new soil gas wells installed at the Site or nearby areas).

### 3.6.4 Corrective Action Progress Reporting

Results of the each quarter's groundwater sampling and air monitoring data will be summarized in a quarterly remediation progress report. As the groundwater monitoring program is continued, plume stability and projected time-to-cleanup analyses will be performed. Plume stability analyses will be performed using the Mann-Kendall trend test outlined in the Appendix 3 of the 2001 IDEM RISC Technical Guide. The need for additional remediation steps (if needed) will continue to be evaluated based on plume stability status, the trends in indicator compound concentrations and evaluation of groundwater geochemistry. A Site closure report will be submitted either when indicator compounds for the Site remain below the remedial objectives for eight (8) consecutive quarters, or when the cVOC plumes have been determined to be stable or decreasing via statistical analysis or sequential dechlorination transport modeling.

### 3.6.5 Remedial Progress Evaluation

Soil data previously collected during the investigation phases of the Michigan Plaza site beneath the plaza building and adjacent to the impacted area beneath the sewer line will be used to determine the achievement of soil closure goals. Confirmation sampling by IDEM in selected areas may be completed to further demonstrate achievement of remediation goals. Groundwater data collected during the historical and ongoing quarterly monitoring events will be used to determine the effectiveness of the groundwater remediation efforts. Vapor mitigation system data from seven (7) operating systems and indoor air quality data from the plaza building and three Maple Creek Village apartment buildings will be used to assess the cleanups effectiveness for achieving acceptable indoor air.

The groundwater data indicating the levels of PCE, TCE, cis-1,2-DCE and VC from both upgradient and downgradient monitoring wells will be analyzed for absolute concentration values and trends to assess the status of the remediation.

#### 3.6.5.1 Monitoring Parameters

Groundwater samples will be tested for the shorter list of shorter list of Volatile Organic Compound (VOC) analysis (PCE, TCE, Cis-1,2-DCE, VC) utilizing U.S. EPA SW-846 Method 8260. The in-situ geochemical parameters temperature, pH, dissolved oxygen, conductivity and oxidation-reduction potential will be measured using the Troll 9500 multi-parameter meter to help determine if conditions naturally conducive to natural attenuation continue to exist in the aquifer. Additional aquifer parameters, consisting of nitrate/nitrite (EPA 353.2), sulfate (ASTM D512-90,02), ferrous iron (field test - 1,10 Phenanthroline), total organic carbon (SM 5310C), methane (AM20GAX), ethane (AM20GAX) and ethene (AM20GAX) will be analyzed to evaluate indicator compound breakdown and redox-sensitivity. Finally, volatile fatty acids (VFA) will be tested to evaluate the bioremediation substrate CAP18 ME$^{TM}$ distribution and lifetime duration of the substrate product.

Vapor mitigation stack air samples and indoor air samples will be tested for the shorter list of VOCs using Method AM4.02.

#### 3.6.5.2 Remedial Sampling Frequency

The sampling frequency for groundwater and vapor mitigation air samples will continue to be on a quarterly basis. The frequency for indoor air is currently completed on an annual basis.

#### 3.6.5.3 Remedial Results Submittal to IDEM

The results will be provided to IDEM in the Quartering Monitoring Reports submitted at the end of the month following each sampling quarter.

#### 3.6.5.4 Evaluation of Monitoring Data

The data will be provided in both tables and graphical form (trend charts) and will be compared to both the remedial goals and the upgradient groundwater quality. Active remedial action at the Site will conclude with demonstration through confirmation sampling that applicable remedial cleanup criteria have been met, as set forth in the RWP.

### 3.6.6 Contingency For Not Meeting Remedial Goal

If the remedial goals have not been achieved, further analysis will be conducted to determine the reason behind the observed behavior of the remaining chlorinated plumes and what, if any, active remedial action steps can be conducted to achieve the goals.

#### 3.6.6.1 Remedial Progress Evaluation

This data will be reviewed and analyzed using statistical methods to demonstrate the chlorinated plumes are stable or decreasing. In addition, if necessary, groundwater and air transport modeling will be completed to demonstrate that the plumes will not pose unacceptable risk to human health and the environment. Reviews of in-situ geochemical parameters will be made to determine if the bioremediation processes are still active and effective, and if additional chemical source area specific injections may be beneficial. Site-specific soil gas, indoor air and vapor mitigation system stack air sample results will be analyzed to determine if the remedial goals are being met, or that site-specific adjustments to those goals can be made in light of actual exposures. Finally, additional site-specific engineering and institutional controls will be considered as part of a formal closure strategy if it is deemed necessary.

#### 3.6.6.2 Remedial Progress Evaluation Frequency

The remedial progress data will be reviewed and evaluated on a quarterly basis as it is generated. In order to allow sufficient time for the new injections to work, absent unusual circumstances, we would not expect to re-evaluate the need for more specific action until at least 12 months after the injection.

#### 3.6.6.3 Corrective Action for Remedial Progress

If sufficient remedial progress has not been made, or if the remedial goals have not been achieved, MUNDELL, together with AMMH, will meet with IDEM to discuss specific action steps to meet cleanup progress objectives or achieve the remedial goals. If necessary and appropriate, additional injections will be considered as part of the strategy.

### 3.6.7 Background Concentration/Mass Flux Evaluation for Closure

Depending on the level of remediation that has been achieved and the need to evaluate upgradient background cis-1,2-DCE and VC levels migrating onto the Site from the Genuine Site, MUNDELL proposes a plume flux and mass discharge basis as the determining factor for when site closure will occur for background conditions. MUNDELL recommends that mass flux calculations of cis-1,2-DCE and VC in the deep zone of the upper sand unit be made, and that closure will occur when it can be demonstrated that

the mass flux coming into the upgradient portion of the Site is equal to the mass flux that is present throughout the remainder of the remediated cVOC plume. This will be determined using cis-1,2-DCE and VC groundwater concentrations defined at specified 'transects', and using the average concentrations from the prior eight (8) quarters of monitoring data.

In order to assist in establishing a tentative background cis-1,2-DCE and VC closure level, MUNDELL will conduct a mass flux evaluation using the 'Mass Flux Toolkit', a Microsoft® Excel based software tool developed for the Department of Defense's Environmental Security Technology Certification Program, or an equivalent analysis. Mass fluxes will be calculated across transects, one immediately upgradient of the Source Areas and two or three downgradient of the Site. Each transect will be placed at a location where monitoring wells are perpendicular to the direction of groundwater flow. Average cis-1,2-DCE and VC concentrations will be used to determine mass fluxes at each transect.

### 3.6.8 Soil Confirmation Sampling (optional)

Following the operation of the optional SVE mobile unit for a period of one year, MUNDELL proposes soil confirmation samples be collected utilizing a Geoprobe™ at representative locations in the Source Areas to evaluate soil quality in the vadose zone and in the saturated zone as a gauge of soil and groundwater remedial progress. Soil samples will be field screened and submitted for analysis of shortlist cVOCs utilizing U.S. EPA SW-846 Method 8260. Samples will be collected for analysis from the historically most affected interval, in addition to the most elevated screened interval, if different from the pre-targeted confirmation interval(s).

### 3.6.9 Contingency Plans for Residential Water Well Contamination

If, contrary to MUNDELL's expectations, the remediation of the Site causes unforeseen groundwater impacts to the west of Holt Road, AMMH will propose a remedial or mitigative plan to address the impacts. Options that will be explored will include: hooking up affected residences to a municipal water supply, or installing a remedial treatment system to intercept the VC plume.

## 3.7 Projected Work Schedule

Quarterly sampling commenced during the first quarter of 2007 and is ongoing. The initial CAP18 ME® injection application occurred from August 1, 2007 through September 4, 2007, with supplemental injections in February 2009 and July 2013. "Annual" groundwater sampling events are scheduled for the 2nd quarter of each year. A final *Remediation Completion Report* is scheduled to be filed with IDEM no later than 2017, but may be realized earlier depending on remediation progress at the Site.

Remedial action at the Site will conclude with demonstration through confirmation sampling that IDEM RCG Cleanup Levels have been achieved for the COCs in groundwater and Indoor Air. Site closure with institutional controls will be pursued either when:

- cleanup goals have been achieved and maintained for a two-year monitoring period, or

- when the groundwater plumes have been shown to be stable or decreasing through statistical evaluation or sequential dechlorination transport modeling.

At the time of site closure, a certificate-of-completion (C-o-C) and a covenant-not-to-sue (CNTS) will be sought from IDEM and the Governor's Office of Indiana.

**Table 10** has been provided to communicate the anticipated schedule of groundwater monitoring, air monitoring and reporting requirements. The timeline offered in this table is proposed, and because it cannot yet be predicted how long remediation will be required, a definitive year of closure is only shown as an estimated value. The next year of testing and evaluation will help better determine the effectiveness of these remediation activities and any remaining activities warranted.

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